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WORLD OIL

PECIALIZED FOR EXPLORATION, DRILLING AND PRODUCING OPERATIONS AND MANAGEMENT

DECEMBER
1959

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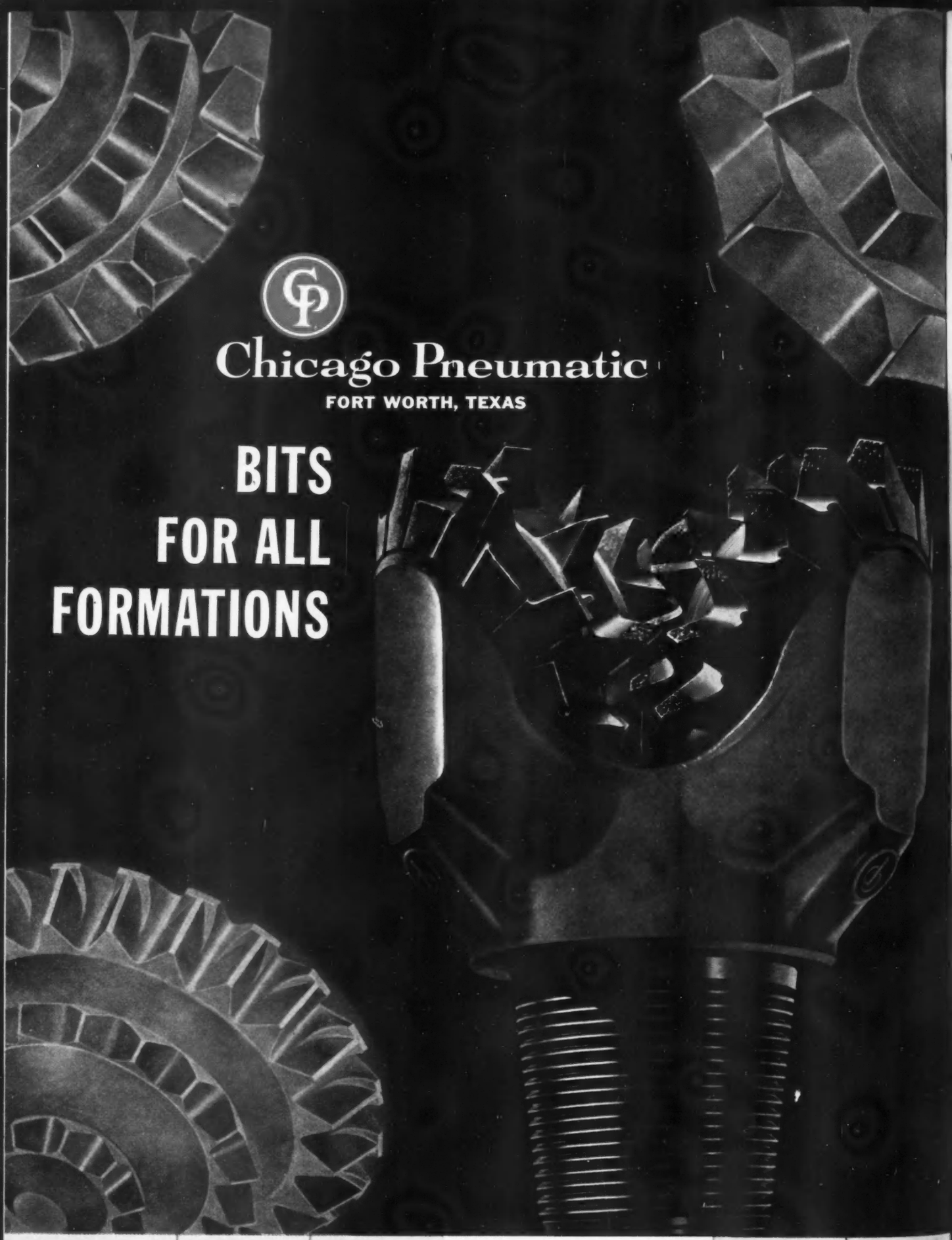
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WORLD OIL

A Gulf Publishing Company Publication

SPECIALIZED FOR EXPLORATION, DRILLING AND PRODUCING OPERATIONS AND MANAGEMENT

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Coming in February . . . the annual Forecast-Review Issue

WORLD OIL published every month except semi-monthly in February and August. Second class postage paid at Houston, Texas.

a Quick Look at this issue . . .

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☑ those you want to read first.

☐ **How to cut sour gas well completion costs . . .** Shell Oil Company of Canada has reduced completion costs an average of $16,000 per well by using calculated hydrate curves and temperature surveys to predict the subsurface "freezing" or hydrate problem in sour gas producers. The method also can be used to determine efficiency of hydrate control systems already installed. If the method indicates that hot oil circulating strings are not required in a particular case, additional savings of $30,000 per well can be realized since the well can be completed with 5½-inch instead of the usual 7-inch casing. For complete information on the method, see Page 83.

☐ **Are milling tools being properly used? . . .** Milling operations should be considered as a "planned" operation instead of a "last resort." Far too often the results can be traced to improper tools or to personnel unfamiliar with the use of milling tools. Also, the operator does not know what to expect from a specific operation. For an informative description of the different types of tools that are used while milling, plus the results that should be expected from each operation, turn to Page 89.

☐ **North Dakota has Mesozoic facies changes . . .** Extensive studies of the upper Jurassic and lower Cretaceous beds in the subsurface in North Dakota indicate that the Jurassic-Cretaceous boundary is gradational, not marked by an unconformity as previously thought. Rapid and complicated facies changes, both vertical and lateral, indicate potential future oil and gas production from localized stratigraphic traps in upper Jurassic and lower Cretaceous sandstones . . . See Page 93.

☐ **Search is on for new Kentucky pays . . .** Operators from Michigan, California, Texas, and Oklahoma are joining the search to find adjacent trends in the wake of central Kentucky's Greensburg oil boom. Leasing and exploratory activity are extending to Indi-

Watch for this special reading bonus

SUBJECT

THE FIRST Production Practices Manual to be published that describes completely the equipment used in producing natural gas—written especially for the production man.

WHY A MANUAL ON GAS WELL EQUIPMENT?

- In this era of proration, a "good" gas well will provide considerably more revenue than a "good" oil well.
- Thus, producers now are more concerned than ever in collecting, drying and selling gas that was flared as useless only a few years ago.
- Now, as never before, production personnel are required to specify, select and buy gas well equipment.
- Because of this increased interest, an urgent need has arisen for a *single source* of information that describes and illustrates in detail separation, dehydration and hydrocarbon recovery equipment.

R. W. Scott

WHAT THE MANUAL WILL CONTAIN

WORLD OIL will publish the Production Practices Manual in the January-February 1 issues.

Part 1 of the Production Practices Manual (January 1960 issue) will cover conventional separators, long cycle dry desiccant dehydrators, calcium chloride dehydrators and mechanical low temperature separation units. Part 2 (February 1, 1960 issue) will discuss glycol dehydrators, short cycle dry desiccant dehydrators and ammonia refrigeration units as applied to low temperature separation.

Each section in the manual will include the following:

A. Discussion of basic equipment

B. How each type unit operates

C. Advantages and disadvantages

D. Recommended operating practices

E. Trouble shooting information

F. Flow diagrams and schematic drawings of equipment.

ana, Ohio and Tennessee on both sides of the Cincinnati Arch and the Nashville Dome. Meanwhile, operators in the prolific shallow Greensburg field are continuing development activity 18 months after the initial discovery. . . . See Page 98.

☐ **Earnings are up in 1959, and further gains are promised . . .** Oil industry earnings remained a little ahead of last year in the third quarter and showed a 15.7 percent gain for the first 9 months. If fourth quarter profits equal those of last year, the increase for 1959 over 1958 will be about 11 percent. Some improvement in prices and a predicted 4 percent increase in demand may boost earnings in 1960 by at least 5 to 10 percent over 1959. See.....Page 102

☐ **Major discoveries spur huge play in Canadian North . . .** Oil and gas finds of significant proportions have given new impetus to exploration in the Northwest-Yukon Territories, and north into the Arctic Islands. Large structures, great thicknesses of sediments and much evidence of folding and seepages are being examined by numerous ground parties. At least 15 drilling projects may get underway in the far north this winter. . . See Page 103.

Continued on Page 6

starting in January

HOW THE MANUAL WAS OBTAINED

To obtain the most complete, authoritative information available, WORLD OIL contacted the men most qualified to know gas well producing equipment—the equipment manufacturers. Six authors from five different manufacturers have undertaken this cooperative effort to bring you the best material available.

Each section of the manual was checked and approved by all authors, assuring an exclusive, unbiased, straightforward presentation.

Robert W Scott

Oil Industry In Brief

Here are the latest economic trends, revealed by WORLD OIL and industry research:

On the plus side

Earnings are up. During first three quarters, 46 companies reported net profit of $2.02 billion—15.7 percent more than same '58 period . . . See Page 102.

Demand to increase. 1960 petroleum use is expected to increase 4 percent over 1959, keeping pace with business upswing that will follow steel strike . . . See Page 25.

Markets improve. Fuel oil markets improved during late November. Wholesale heating oil prices were up ¼-cent per gallon in Mid-Continent. Increase brought price back to year ago levels . . . See Page 25.

More footage drilled. 169.8 million feet of hole were drilled during first 10 months of '59—up 4.3 percent over same '58 period . . . See Page 29.

On the minus side

Oversupply continues. Demand drop in October added to excess crude oil and product inventory woes. Stocks of all oils increased 368,000 barrels daily, compared with increase of 199,000 daily in October last year . . . See Page 25.

Wage-price inequity continues. Oil industry production wages increased 81.8 percent between December 1947 and September 1959, while crude oil prices increased only 24.7 percent . . . See Page 17.

Rig totals decline. Following three-month downward trend, active rigs totaled 4,084 on October 31, down 3.4 percent from September's end and 5.8 percent from same date in '58 . . . See Page 29.

Ineffective communications. Recent natural gas industry survey of 3,500 Americans reveals 82 percent of those polled had never heard of, or knew nothing about the depletion provision . . . See Page 13.

Drop in well completions. Although October new well completions increased 2.3 percent over September, the average of 135 completions per day was still 5.4 percent under October '58 average . . . See Page 29.

QUICK LOOK at this issue . . .

☐ **Here's how to improve your gas lift installations (Part 5) . . .** Operators can estimate the volume of injection gas by intermittent gas lift wells easily and accurately with this practical method. The procedure is based on the volume of injection gas required to obtain a given pressure build-up in the casing during an injection gas cycle. A complete description of the method, including several problem samples, is presented on **Page 107.**

☐ **South Dakota oil prospects becoming better known . . .** Mesozoic and Paleozoic beds have indicated many oil and gas shows, notably in the Williston Basin, where significant pumper oil production has been established at Buffalo Field in Harding County; and in areas surrounding the Black Hills. The Kennedy and Forest City basins extend into the state from Nebraska. Oil shows have even been found in Precambrian strata in South Dakota . . . **See Page 112.**

☐ **Geologist's interpretation of drilling mud requirements . . .** Continued emphasis is being placed on reduced drilling costs, and immense strides have been made in that direction. However, occasionally it has been at the expense of proper evaluation of horizons penetrated. For ways in which mud programs can be designed to reflect good electrical logging environment and lithology evaluation, turn to **Page 116.**

☐ **Computing present worth of oil properties . . .** A series of recently developed charts permits fast, accurate determination of the present worth of royalty and working interests. Graphs are computed on a monthly basis and may be used for most ranges of interest rates and decline rates . . . **See Page 122.**

☐ **Prospects vary widely in northern South America . . .** Major reserves continue to be found in both western and eastern Venezuela. Possibilities remain fair to good in the Barinas-Apure Basin, the most recent to be opened to commercial production. In Colombia, several basins have been proved oil-bearing, and vast areas remain to be tested. In Ecuador, the search is continuing for new oil provinces. Illustrated with generalized sedimentary sections for each area of interest, this article is the concluding part of an exclusive WORLD OIL series devoted to South American oil prospects . . . **See Page 130.**

Exclusive! New drilling technique

A new drilling method that recovers 100 percent continuous core at the surface, using reverse circulation, has been successfully field tested near Abilene, Texas. Equipment used includes dual drill pipe, a highly portable rig, electric swivel, and a new circulation method. For a fully illustrated description of the new method, plus authoritative comments on its potential, be sure to see your January WORLD OIL.

WORLD OIL

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GPC PUBLICATIONS

WORLD OIL (formerly The Oil Weekly) and The COMPOSITE CATALOG for the drilling-producing industry.
PIPE LINE INDUSTRY and The PIPE LINE CATALOG for the oil and gas pipe line industry.
PETROLEUM REFINER and The REFINERY CATALOG for the oil, gas and petrochemical processing industry.

Indexed by Industrial Arts Index and Engineering Index

Looking Ahead

API Meeting Stresses Oil Industry Outlook—Economics—Government Affairs . . Record number of oil men (more than 6,600) attending API annual meeting in Chicago last month heard both the dark and the bright side of oil's future. Following are some of the comments heard on the outlook for oil and gas:

William F. Butler, vice president, Chase Manhattan Bank . . . Speaking on general business conditions, he predicted that from 1959 third quarter to 1960 third quarter, inventory accumulations will increase $6-8 billion—foreign trade will be up $1.5 billion—business plant and equipment investment will jump 18 percent or $8 billion—gross national product will increase from $481 billion to $520-525 billion.

M. E. Hubbard, The British Petroleum Company, London . . . In next 20 years, world petroleum reserves will increase from present 205 billion barrels to 425 billion—U.S. will find and develop 100 billion barrels during this period.

Donald K. Russell, Lehman Corporation . . . said pessimistic impressions of production industry are unjustified. He offered this solution to current oil industry economic problems: Tight import controls on crude and products—crude oil price increase to $3.50 per barrel within 10 years, and 19 cents per Mcf for natural gas—reduce refinery runs to 5 percent below normal.

Petroleum Equipment Suppliers' Directors Meeting . . . 50 directors attending generally agreed that despite steel strike, prospects appear encouraging for '60—number of wells drilled will be greater than '59—subject to supply difficulties resulting from steel strike, suppliers are preparing for an active year.

On oversupply . . .

L. F. McCollum, President, Continental Oil Company . . . Pessimism regarding U.S. oversupply is changing to optimism—oversupply has been building since World War II, with reserve ratio to annual production increasing from 20 to 1, to 43 to 1—recent economic study predicts oversupply situation will last five more years, as opposed to previous 10-year forecasts.

H. S. M. Burns, President, Shell Oil Company . . . Excess refinery runs are having greater effect on current oversupply than imports—however, overcapacity is being corrected by absence of any refinery building—present refinery overcapacity should be corrected by 1964 or 1965.

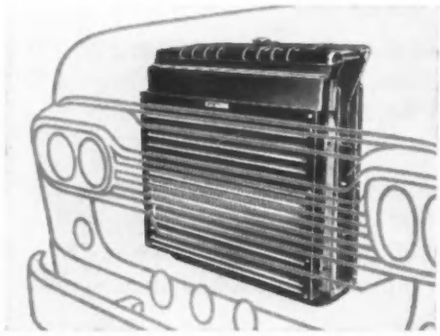
On government affairs . . .

Frank M. Porter, API president . . . Disagreed with Interior Secretary Seaton's recent advice that the petroleum industry should start new natural gas bill campaign—said any new bill must be launched and strongly supported by the White House—expressed doubt that a serious Congressional fight will be made to kill or decrease depletion provision during 1960—lambasted coal's effort to create national fuels policy based on end-use controls as a campaign to eliminate competition from natural gas and certain crude oil products in some markets.

Minor S. Jameson, Jr., executive vice president, Independent Producers Association of America . . . Predicted government policy regarding oil and gas will be a controlling factor as to whether the industry will have necessary incentive to find the 100 billion barrels of petroleum reserves that will be needed in the next 20 years.

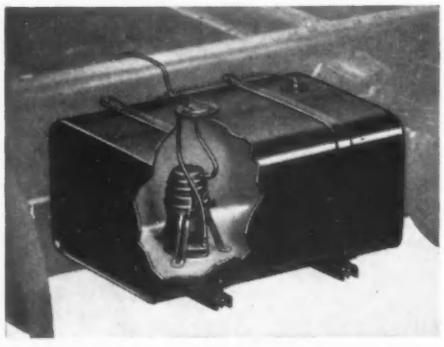
J. Howard Edmondson, governor of Oklahoma . . . Called on the oil industry to continue its fight for freedom from natural gas regulation—stop inter-industry squabbling—continue efforts to restrict imports—participate more actively in politics.

NOW! Certified Durability i



CLOSER TEMPERATURE CONTROL obtained with automatic radiator shutters means longer engine life, more efficient operation. Temperature variation between 167° and 187° with shutters as compared to 102° to 181° without shutters was reported and certified in loaded vehicle road tests.

LONGER WIRING HARNESS LIFE is the direct result of Ford's greatly improved electrical wiring system for 1960. Ford's '60 wiring harness and the 1959 wiring harness were subjected to shaker table tests plus constant exposure to oil and water vapors, and temperatures of 200°. Certified test results show a threefold increase in 1960 wiring harness life.



INCREASED FUEL PUMP RELIABILITY is an added benefit from Ford's submerged-type electric fuel pump. Certified results of dynamometer tests showed no vapor lock with Ford's electric pumps at temperatures up to 200°, whereas incipient vapor lock with mechanical fuel pump resulted in a power loss of 9% under same conditions.

It's a fact! Numerous reports from high-mileage operators of Super Duty Trucks attest to Ford's outstanding durability. Studies by an independent research firm provide certified proof that these models are even more durable for 1960.

Ford Super Duty Trucks have earned a reputation for exceptional performance and durability since their introduction two years ago. Shop service records of many leading fleets show Super Duty tractors with mileage readings between 150,000 and 250,000 and no repairs other than normal maintenance. Similar testimony to the dependability of these Big V's by other satisfied users is being added each month. Is it any wonder that '59 sales of these units were more than double those of 1958?

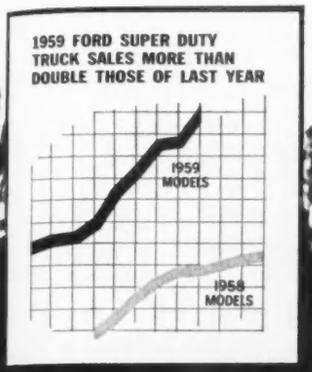
And for 1960, the Ford Super Duties offer additional refinements. Bigger optional axles and increased GVW's to permit greater payloads and more profitable operation. Automatic radiator shutters to keep the engine temperatures within the most efficient operating range, improved submerged-type electric fuel pumps to prevent vapor lock, and redesigned wiring for more reliable operation are typical of the improvements to be found in these units.

The changes offered for 1960 were tested and evaluated by a leading research organization. Certified results of the studies by this impartial firm (name available on request) provide proof that Ford's Super Duty Trucks are even more dependable.

- **Certified Durability through closer temperature control!** Independent research engineers certify that Ford's thermostatically controlled radiator shutters kept water temperature between 167° and 187° in severe mountain grade operation. The test truck with shutters blocked open under same operating conditions had a temperature range from 102° to 181°. The temperature variation of only 20° with shutters means less expansion and contraction in block and heads. Higher, more constant temperatures permit oil to circulate more freely, reducing internal friction. All these factors contribute to longer engine life.
- **Certified Reliability with longer-lived electrical system!** Thicker insulation on wires resists deterioration by heat, oil and gasoline. Asphalt-impregnated loom and plastic-coated mounting clips protect against abrasion. Certified results prove that the 1960 wiring harness has three times longer life.
- **Certified Reliability with Ford's submerged-type electric fuel pump!** Dynamometer tests of engines with submerged-type electric fuel pump and conventional mechanical type showed that vapor lock was non-existent with Ford's electric pumps at temperatures up to 200°, whereas incipient vapor lock with mechanical pump resulted in a power loss of 9% at an underhood temperature of 200°.

Endurance tests were run on alternators, two-speed axle speedometer adapters and other related components with similar results. Get all the facts at your Ford Dealer's now!

in Ford Super Duties!



"Our first Ford C-1000 tractor has logged 190,000 trouble-free miles since March of '58,"

says Robey W. Estes, Vice President and General Manager of Estes Express Lines, Richmond, Va. "We haven't had a single road failure and we only bring it into the shop for regular preventive maintenance work once a month.

"We use the 477 engine and find oil consumption is exceedingly low . . . only one or two quarts added between 3000-mile oil changes. Engine compression at 190,000 miles is still high and fairly equal and our drivers say that power and pep are at about the same level as when the truck had been run only 60,000 miles.

"We are grossing between 52 and 56,800 pounds with our Ford Tilts. They are giving about the same gas economy and better oil mileage than other makes in our fleet. We bought our fourth Ford C-1000 tractor last month and hope to add more soon."

FORD TRUCKS COST LESS

LESS TO OWN . . . LESS TO RUN . . . BUILT TO LAST LONGER, TOO!

Good Wells Make Good News

A Monthly Report On Wells That Are Now Worth More

December, 1959

This month, the jobs reported are more of those engineered by Dowell with the aid of the "Frac Guide"*. You will notice the excellent results.

- **Greenwood County, Kansas** (New Oil Well) This open hole completion was made into the Bartlesville sand from 1837 to 1862 feet. Production was only one bopd. Dowell engineers recommended Waterfrac on the basis of calculations made with the "Frac Guide". 5000 gallons gelled water with FLA* (Fluid Loss Additive) and 20,000 pounds sand were injected down casing at 27 bpm and 800 psi. Five days after treatment, well was flowing 100 bopd with only a show of water.

- **Brazoria County, Texas Gulf Coast** (Old Gas Well) Gas production had declined to only 417 mcfd. Pay was the shaly Frio sand from 6214 to 6224 feet. The "Frac Guide" indicated the use of Acid Petrofrac*. Dowell injected 5000 gallons acid-oil emulsion and 15,000 pounds 40-60 sand at 6 bpm and 4400 psi. Treatment was made through tree down 2½-inch tubing, allowing the operator to avoid using a workover rig. Production rose to 9000 mcfd — more than a twenty-fold increase.

- **Glasscock County, West Texas** (Old Oil Well) This Spraberry well had depleted both the lower Spraberry and the shallower Clearfork. The operator plugged off both these zones and re-completed into the upper Spraberry by perforating the casing from 6870 to 6905 feet. Then Dowell engineered a treatment with the "Frac Guide" using 10,000 gallons refined oil, a fluid loss control agent, 35 perforation ball sealers and 45,000 pounds sand. After treatment, which was down 3-inch tubing, the well potentialed 93 bopd.

- **Montague County, North Texas** (New Oil Well) This well swabbed only one boph after completion into the conglomerate through three sets of perforations between 5852 and 5928 feet. Dowell engineered a four-stage down-casing fracturing treatment that included 40,000 gallons gelled crude, 60 ball sealers, 2000 pounds of a fluid loss control agent and 94,800 pounds sand. Before the treatment, 500 gallons of Mud Acid was used to wash the formation and the well was swabbed. After treatment, well tested 432 bopd, flowing on ½-inch choke.

In area after area, Dowell continues to get improved results with the "Frac Guide". Take advantage of this experience to help you get the results you want. For service or detailed information, contact the Dowell office or station nearest you. There are more than 165 locations in the United States, Canada, Venezuela and Argentina. Dowell, Tulsa 1, Oklahoma.

*Dowell Trademark

Services for the oil industry DOWELL
DIVISION OF THE DOW CHEMICAL COMPANY

Too many economic illiterates

Did you know that——

Oil industry production wages increased 81.8 percent between December 1947 and September 1959, while crude oil prices increased only 24.7 percent?

• • •

In the past 12 months the Consumer Price Index increased 1.2 percent, while the hourly manufacturing earnings increased 3.37 percent?

• • •

In the 20-year period, 1939-1959, the Consumer Price Index increased 107.9 percent, while average hourly manufacturing earnings increased 236.5 percent?

• • •

Average hourly earnings have increased more rapidly than the Consumer Price Index in all but three years since 1938?

• • •

Labor costs represent 70-80 percent of the final prices of products we buy?

• • •

These are facts, not fiction. The first four facts were taken from the U.S. Bureau of Labor Statistics reports. The last comes from the U.S. Chamber of Commerce.

Chances are that few persons know anything about any one of the above statistics. To give but one example, two months ago Gov. Albert D. Rosselini of Washington State said that wages had not gone up as much as prices. This information was widely publicized throughout the northwest. Only one newspaper called the governor to task for spreading this misinformation.

It is true that increased efficiency of operations, improved equipment and automation have made it possible to hold prices down to some extent while wages shot upward. But, even these factors can go only so far—witness the almost inevitable increase in steel prices with every wage increase.

Why is it that, despite the facts, many believe prices have risen faster than labor costs in recent years? Why is it that the U.S. public demands antitrust enforcement of competitive price making, while in the market which governs the most important component of those prices—the price of labor—allows and even encourages monopolistic practices?

Prof. Edward H. Chamberlain of Harvard University sums up the answer quite simply—too many of us are economic illiterates. In his words:

". . . Nobody is surprised if higher raw material costs increase the price of the finished product; so why it should be thought that higher labor costs would have the special property of coming out of profits without affecting prices is a major mystery.

"In other words, the gains of any particular concentration of labor power are paid in the end by the general consuming public as surely as are those of any industrial monopoly. The public has exactly as much interest in the terms of the contract between labor and management as it has in industrial prices and in the prices of commodities at retail which it purchases directly.

"And the fact that the public doesn't know it is one of the major sources of power in the hands of labor unions."

Though part of the blame for this situation can be placed on labor unions, so also must industrial management and the nation's press assume their share. Industrial management generally has not informed its employes about the impact wages have on prices. Neither has the nation's press adequately informed its readers. And, of course, the labor unions have not been quick to emphasize the public interest.

Now comes the longest steel strike in the nation's history, with the threat of new wage increases and the possibility of another price hike in steel products. What a perfect time for labor, industrial management and the press to assume their responsibility of educating the U.S. public.

If such action is not taken soon, we may well find ourselves in an even wilder inflationary spiral. In fact, we may well price ourselves entirely out of the Free World market.

To Provide Service Is To Understand

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LIBERTY is dedicated to the understanding and consideration of the problems of both Supply Stores and Producers.

LIBERTY has worked closely with the petroleum production industry for over 40 years to produce fine sucker rods and pumping units for a rapidly advancing petroleum technology.

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Better results are in prospect for 1960

THE OIL INDUSTRY'S outlook for late 1959 and the year 1960 is one of probable gradual improvement. Following the trying times of 1958 and 1959, caused by business recession and petroleum surpluses, oil companies apparently can hope for better results in 1960. The betterment is promised as a result of several favorable factors.

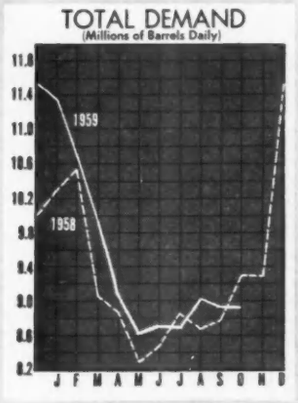
- A general business boom is widely expected.
- This boom will directly and indirectly stimulate demand for petroleum products. High sales of automobiles, for example, will generate greater consumption of gasoline. And increased industrial activity will help sales of fuel oils and lubricants.
- Total demand for petroleum probably will be at least 4 percent greater in 1960 than in 1959. And to some extent, the extra business can be handled without proportional increases in costs, by taking advantage of unused capacity and continuing economy measures.
- Better markets and prices in the oil industry are promised. Improvement over the depressed prices of 1958 and 1959 is hoped for as a result of strict curtailment of crude production and reduced refinery runs of crude since the middle of 1959. The effective control of supply, coupled with prospective good demand, is stabilizing markets and promises to put prices at more profitable levels.

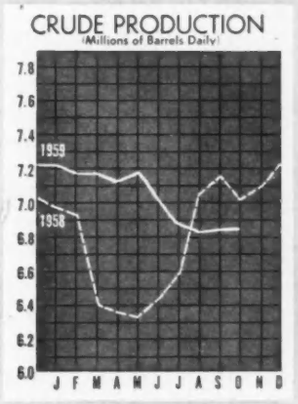
In the week after the middle of November there was some definite improvement in the markets for fuel oils. Prices of heating oils at wholesale were marked up ¼ cent a gallon in the Mid-Continent, as cold weather stimulated sales. The increases brought the prices back up to year-ago levels. Residual fuel oil also was in growing demand, as industrial activity expanded following the end of the steel strike. The gasoline market remained steady, although in a season of lower demand.

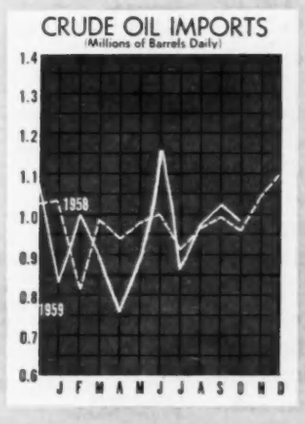
The latest available statistics on industry operations, covering October, reflect several abnormal factors and therefore are not very significant.

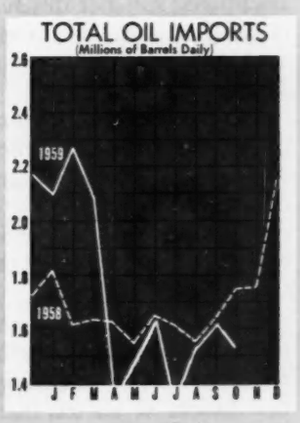
Continuing problems in the crude

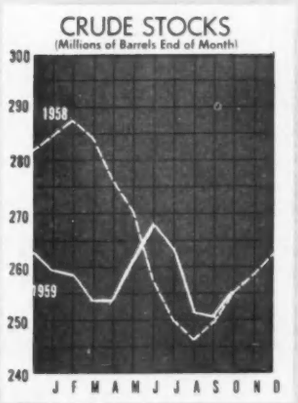
Petroleum Trends...

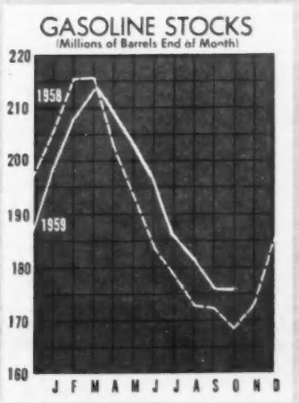


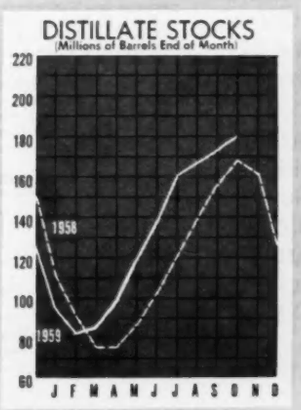


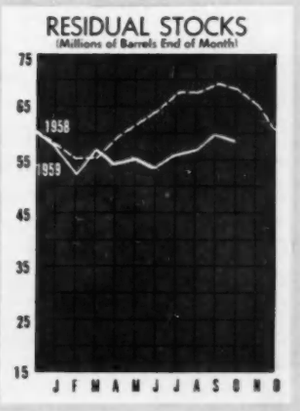












oil markets were spotlighted at mid-November when Carter Oil Company cut its posted prices for Montana crude by amounts ranging from 25 to 45 cents a barrel. Cut Bank 40 gravity crude was cut from $2.98 to $2.73, and lower gravities were put on a 3 cent differential instead of 2, cutting 20 gravity and less from $2.58 to $2.13 a barrel. Price cuts had been made previously by some other purchasers.

The latest available statistics on industry operations, covering October, reflect several abnormal factors and therefore are not very significant. They show that demand for petroleum in October was down contraseasonally from September and under October last year by 4.6 percent. Decreases for products included 2.5 percent for gasoline, 3.6 percent for distillate fuel oil, and 2.7 percent for residual fuel oil.

Demand for gasoline was off in October because large amounts were bought in advance in September to avoid the extra federal tax of one cent a gallon effective October 1. Gasoline demand dropped to 4,010,000 barrels daily in September from 4,325,000 daily in September and was lower than the 4,112,000 daily of October last year.

Distillate fuel oil demand also may have shifted into September from October to some extent for price reasons, with buyers taking advantage of traditional summer discounts. The industrial slow-down during the steel strike also may have retarded distillate sales in October.

Residual fuel oil consumption certainly was lowered by the steel strike and accompanying industrial slowdown. Decreases were experienced during the strike, whereas there were increases over 1958 in the first half of this year.

Stocks of crude oil and products were affected adversely by the relatively low levels of demand in October. Stocks of all oils increased 368,000 barrels daily, compared with an increase of 199,000 daily in October last year. Crude stocks rose by 171,000 barrels daily and product stocks by 197,000 daily.

Crude stocks of 256,300,000 barrels October 31 compared with only 251,000,000 September 30. But they were only slightly above the 255,300,000 barrels of October 31 last year. And they were still 16 million barrels under the peak of 272,505,000 barrels reached July 31 this year.

U.S. Petroleum Demand and Supply (Thous. Bbls. Daily)

ITEM	October 1959	October 1958	% Dif.	Sept. 1959	January-October 1959	January-October 1958	% Diff.
DEMAND							
All Oils, Total Demand	8,913	9,343	— 4.6	8,994	9,444	9,122	+ 3.5
Domestic Demand	8,678	9,061	— 4.2	8,744	9,198	8,844	+ 4.0
Export Demand	235	282	—16.7	250	246	278	—11.5
Gasoline, Total Demand	4,010	4,112	— 2.5	4,325	4,136	3,979	+ 3.9
Distillate, Total Demand	1,506	1,562	— 3.6	1,388	1,715	1,691	+ 1.4
Kerosine, Total Demand	270	298	— 9.4	256	274	284	— 3.5
Residual, Total Demand	1,491	1,533	— 2.7	1,271	1,569	1,468	+ 6.9
Other Oils, Total Demand	1,636	1,838	—11.0	1,757	1,750	1,700	+ 2.9
CHANGE IN STOCKS							
All Oil, Change in Stocks	+368	+199	.....	+327	+211	—56	.....
NEW SUPPLY							
Total New Supply	9,281	9,542	— 2.7	9,321	9,655	9,066	+ 6.5
Domestic Production, Total	7,715	7,786	— 0.9	7,700	7,905	7,423	+ 6.5
Crude Oil	6,855	6,977	— 1.7	6,825	7,039	6,638	+ 6.0
Natural Gas Liquids	860	809	+ 6.3	875	866	785	+10.3
Imports, Total	1,566	1,756	—10.8	1,621	1,750	1,642	+ 6.6
Refined Products	568	824	—31.1	598	787	703	+11.9
Crude Oil, Total	998	932	+ 7.1	1,023	963	939	+ 2.5
Crude, East Coast	733	750	— 2.3	784	738	762	— 3.1
CRUDE RUNS							
Crude Runs to Stills	7,667	7,700	— 0.4	7,913	7,985	7,553	+ 5.7
Domestic Crude	6,665	6,746	— 1.2	6,929	7,029	6,622	+ 6.1
Foreign Crude	1,002	953	+ 5.1	984	956	931	+ 2.7

U.S. Stocks of Oils (Million Bbls. at End of Month)

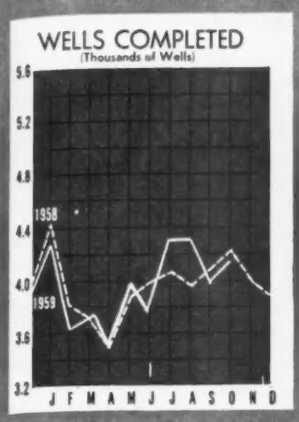
KIND OF OIL	TOTAL IN U.S. Oct. 1959	Oct. 1958	% Diff.	Sept. 1959	EAST OF CALIFORNIA Oct. 1959	Oct. 1958	% Diff.	Sept. 1959
All Oils	845.6	822.8	+ 2.8	834.2	.....	.....	.....	.....
Crude Oil	256.3	255.3	+ 0.4	251.0	223.9	216.1	+ 3.6	217.1
Gasoline	176.0	170.1	+ 3.5	176.6	150.9	147.5	+ 2.3	151.0
Distillate Fuel Oil	181.6	164.7	+10.3	173.9	166.2	150.2	+10.6	158.8
Kerosine	33.0	31.9	+ 3.4	32.2	32.6	31.5	+ 3.5	31.9
Residual Fuel	58.0	67.0	—13.4	59.5	32.4	32.9	— 1.5	33.0
Other Oils	108.3	105.8	+ 2.4	141.0	.....	.....	.....	.....

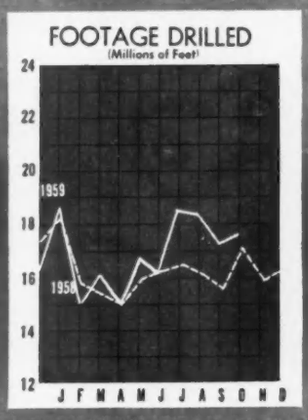
U.S. Crude Oil Production, by States (Thous. Bbls.)

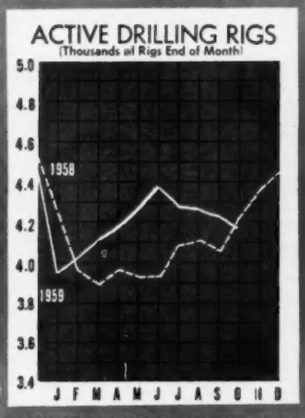
STATE or DISTRICT	Daily Average for Month Oct. 1959	Oct. 1958	% Diff.	Sept. 1959	Total, January-October 1959	1958	% Diff.
Alabama	16.1	18.7	— 13.9	15.6	4,241	4,945	— 14.2
Arkansas	52.4	80.2	— 34.7	47.0	21,461	23,941	— 10.4
California	838.7	855.6	— 2.0	838.5	256,253	262,462	— 2.4
Colorado	127.2	131.0	— 2.9	126.8	38,336	40,554	— 5.5
Florida	1.2	1.2	.....	1.2	356	373	— 4.6
Illinois	214.4	225.6	— 5.0	217.9	65,271	68,382	— 4.6
Indiana	31.6	35.3	— 10.5	32.1	10,024	9,787	+ 2.4
Kansas	325.7	339.4	— 4.0	314.7	99,225	98,115	+ 1.1
Kentucky	72.3	54.8	+ 31.9	73.9	22,517	13,906	+ 62.0
Louisiana	1,041.1	907.3	+ 10.7	993.7	291,316	255,848	+ 13.9
North Louisiana	113.3	110.9	+ 2.3	113.7	36,657	34,766	+ 5.4
South Louisiana	900.8	796.4	+ 13.1	880.0	254,659	221,082	+ 15.2
Michigan	31.5	25.6	+ 23.0	30.1	8,466	7,724	+ 9.6
Mississippi	141.9	114.5	+ 23.9	141.4	39,279	31,300	+ 25.5
Mo.-So. Dak.-Tenn.	0.5	0.4	+ 25.0	0.5	77	108	— 28.7
Montana	80.2	80.8	— 0.7	81.9	24,912	23,545	+ 5.8
Nebraska	65.8	60.3	+ 9.1	66.7	19,344	16,891	+ 14.5
Nev.-Wash.-Alaska-Ariz.	0.5	0.1	+400.0	0.5	167	34	+391.2
New Mexico	291.8	275.0	+ 6.1	297.1	87,821	81,416	+ 7.9
Southeast New Mexico	252.1	245.8	+ 2.6	251.0	75,772	74,970	+ 1.1
Northwest New Mexico	39.7	29.2	+ 36.0	46.1	12,049	6,446	+ 86.9
New York	5.4	3.0	+ 80.0	5.1	1,633	1,499	+ 8.9
North Dakota	44.1	21.0	+110.0	53.0	14,904	11,511	+ 29.5
Ohio	13.6	17.7	— 23.2	14.1	4,606	5,281	— 12.8
Oklahoma	522.1	561.5	— 7.0	501.9	162,767	168,619	— 3.5
Pennsylvania	16.3	18.0	— 9.5	16.0	4,985	5,694	— 12.5
Texas	2,485.3	2,701.4	— 8.0	2,493.9	821,577	769,969	+ 6.7
Dist. 1: South Central	44.5	47.7	— 6.7	44.0	13,784	14,021	— 1.7
Dist. 2: Middle Gulf	109.9	124.3	— 11.6	110.3	35,962	34,655	+ 3.8
Dist. 3: Upper Gulf	350.1	375.0	— 6.6	350.0	116,455	113,197	+ 2.9
Dist. 4: Lower Gulf	178.4	202.5	— 11.9	177.8	58,287	57,095	+ 2.1
Dist. 5: East Central	27.2	31.5	— 13.7	28.6	9,139	9,087	+ 0.6
Dist. 6: Northeast	240.6	276.6	— 13.0	242.8	80,493	77,425	+ 4.0
Dist. 7-B North Central	131.9	144.3	— 8.6	132.5	41,674	41,468	+ 0.5
Dist. 7-C West Central	118.5	142.6	— 16.9	117.7	39,094	40,005	— 2.3
Dist. 8: West	974.5	1,028.8	— 5.3	977.1	322,039	282,888	+ 13.8
Dist. 9: North	201.8	211.5	— 4.6	203.2	62,884	60,287	+ 4.3
Dist. 10: Panhandle	107.9	107.5	+ 0.4	110.0	32,764	32,408	+ 1.1
Utah	106.9	107.2	— 0.3	107.6	33,418	19,314	+ 73.0
Virginia	.....	.....	.....	.....	4	5	— 20.0
West Virginia	6.3	6.4	— 1.6	6.1	1,812	1,841	— 1.6
Wyoming	349.3	335.5	+ 4.1	347.7	104,725	95,045	+ 10.2
Total, U.S.	6,855.2	6,977.5	— 1.8	6,825.3	2,139,497	2,018,109	+ 6.0

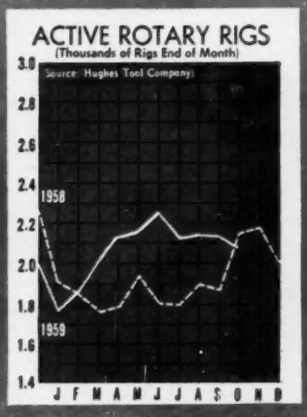
Sources for above 3 tables: Bureau of Mines monthly reports, except last two months based on API and B. of M. weekly reports and WORLD OIL estimates, and all Texas district data from API.

Drilling Activities...









Completions follow WORLD OIL forecast

According to present trends, total new well completions will fall beneath the 50,000 mark as predicted in the World Oil mid-year forecast.

New completions averaged 135 wells per day (4,182 total wells) in October, up 2.3 percent over September, but down 5.4 percent from the 143 wells completed per day during October 1958. A total of 40,542 wells were completed during the first 10 months of 1959, which should bring the year's total near the 49,930 new completions forecast in World Oil's August 15 issue.

Active rigs totaled 4,084 on October 31, completing a three-month downward trend. The October total was down 143 rigs or 3.4 percent from the 4,227 rigs operating at September's end. The September total was down 1.2 percent from August, which dropped 1.3 percent from July. Also, the October total was down 254 rigs or 5.8 percent from the active rigs reported operating on October 31, 1958.

Footage drilled also completed a three-month downward trend, averaging 567,778 feet per day in October, down 1 percent from September, which was 2.9 percent under the August daily average. And the August footage was 2.1 percent under the 603,236 feet per day drilled during July.

Summary of U.S. Wildcat Drilling

ITEM	October 1959	Sept. 1959	TEN MONTHS January–October 1959	1958	% Diff.
New Field Discoveries:					
Oil	49	58	586	607	— 3.5
Distillate	4	8	76	76	.....
Gas	30	28	217	192	+13.0
Total Discoveries	**83**	**94**	**879**	**875**	**+ 0.5**
Dry Wildcats	**833**	**730**	**7,267**	**7,279**	**— 0.2**
Total Wildcats	**916**	**824**	**8,146**	**8,154**	**— 0.1**
(Percent Productive)	9.1	11.4	10.8	10.7	.....
(Percent Dry)	90.9	88.6	89.2	89.3	.....

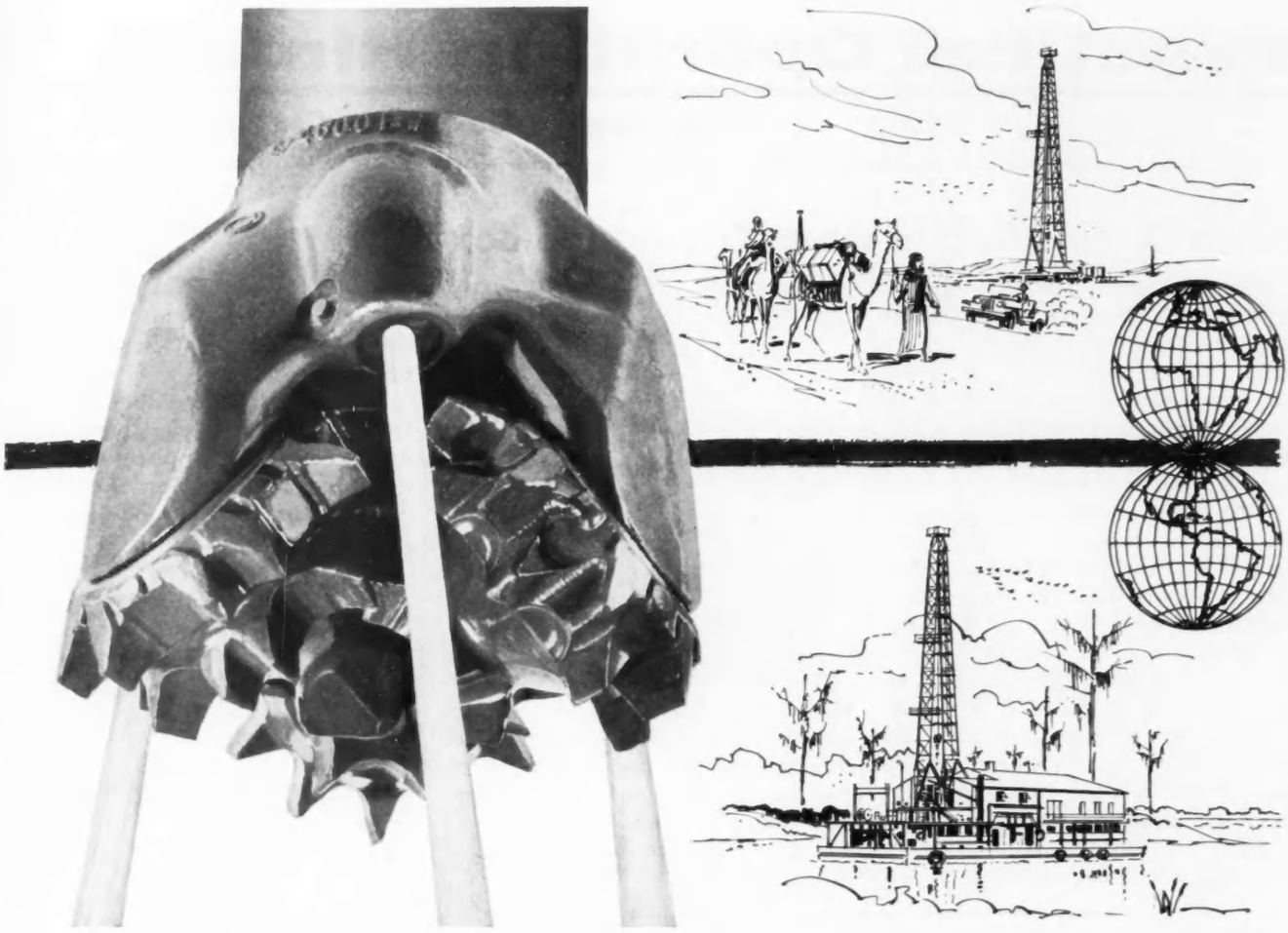
Summary of U.S. Drilling Activity

ITEM	October 1959	Sept. 1959	TEN MONTHS January–October 1959	1958	% Diff.
New Wells Completed:					
Oil	1,987	1,854	20,252	20,034	+ 1.1
Distillate	62	81	685	615	+11.4
Gas	370	364	3,371	3,571	— 5.6
Service	73	60	675	1,089	—38.0
Dry	1,690	1,609	15,386	15,233	+ 1.0
Total New Wells	**4,182**	**3,968**	**40,369**	**40,542**	**— 0.4**
Footage Drilled (Million Feet)	**17.6**	**17.2**	**169.8**	**162.8**	**+ 4.3**

U.S. Drilling Activity in October and First Ten Months, 1959-1958

STATE or DISTRICT	TOTAL NEW WELLS COMPLETED AND FOOTAGE DRILLED: DETAILS FOR OCTOBER, 1959 — Oil	Dist.	Gas	Dry	Service Wells	TOTAL NEW WELLS — Oct. 1959	Sept. 1959	Oct. 1958	Total Footage October 1959	DETAILS FOR JANUARY-OCTOBER — NEW WELLS — 1959	1958	Percent Diff.	FOOTAGE — 1959	1958	WILDCAT DRILLING IN OCTOBER AND FIRST TEN MONTHS, 1959–1958 — DETAILS FOR OCTOBER, 1959 — Oil	Dist.	Gas	Dry	Total Wildcats	DETAILS FOR JANUARY–OCTOBER — Oil	Dist.	Gas	Dry	TOTAL WILDCATS — 1959	1958	DRILLING RIGS IN OPERATION (Rigging up, Drilling, Temp. Shut-Down) — Oct. 31, 1959	Sept. 30, 1959	Oct. 31, 1958
Alabama	6	....	....	1	....	7	9	8	64,563	90	69	+ 30.4	810,467	566,124	....	....	....	1	1	....	....	....	28	28	25	9	8	15
Alaska	....	....	1	1	....	2	1	....	16,671	8	....	....	89,638	....	....	....	1	1	2	1	....	1	5	7	....	7	8	....
Arkansas	43	....	6	32	....	81	78	92	270,386	687	671	+ 2.4	2,300,488	2,250,609	1	....	1	11	13	4	....	8	94	106	130	48	49	56
California	67	....	7	57	11	142	116	104	704,268	1,208	1,193	+ 1.3	5,840,271	5,690,438	1	....	....	38	39	5	....	6	247	258	246	139	137	125
Colorado	18	1	15	46	....	80	61	97	410,043	634	719	— 11.8	3,341,190	3,725,456	4	....	4	30	38	21	....	15	301	337	400	40	58	61
Florida	....	....	....	1	....	1	1	....	11,646	7	6	+ 16.7	60,333	55,809	....	....	....	1	1	....	....	....	7	7	6	3	2	2
Georgia	....	....	....	....	....	....	....	....	....	1	1	....	990	2,915	....	....	....	....	....	....	....	....	1	1	1	....	....	....
Illinois	81	....	....	89	....	170	171	199	372,800	1,699	1,897	— 10.4	3,752,686	4,359,517	....	....	....	39	39	10	....	....	399	409	493	303	320	326
Indiana	25	....	....	55	1	81	76	124	122,492	721	710	+ 1.5	1,142,137	1,152,907	....	....	....	22	22	1	....	1	197	199	192	121	97	113
Kansas	121	....	14	166	5	306	293	381	1,114,862	3,093	3,078	+ 0.5	11,340,039	10,596,361	5	....	5	95	105	114	....	22	820	956	801	294	296	354
Kentucky	141	....	20	103	3	267	259	248	244,766	2,435	1,906	+ 27.8	2,209,032	1,935,075	1	....	....	9	10	10	....	....	66	76	68	190	206	107
Louisiana	146	18	26	142	1	333	358	327	2,452,641	3,177	2,893	+ 9.8	24,696,707	22,490,592	2	1	1	51	55	24	13	12	403	452	491	333	360	356
North Louisiana	64	....	13	67	....	144	142	162	482,503	1,232	1,126	+ 9.4	4,374,418	4,185,170	....	....	....	26	26	13	1	4	153	171	164	67	75	72
South Louisiana	82	18	13	75	1	189	216	165	1,970,138	1,945	1,767	+ 10.1	20,322,289	18,305,422	2	1	1	25	29	11	12	8	250	281	327	266	285	284
*Gulf of Mexico	24	6	2	9	....	41	44	34	416,908	397	418	— 5.0	4,105,456	4,024,834	1	....	1	2	4	2	2	4	23	31	37	54	64	34
Michigan	24	....	6	29	....	59	57	47	195,046	482	320	+ 50.6	1,487,598	920,125	....	....	1	20	21	3	....	3	123	129	112	102	99	77
Mississippi	19	....	3	41	....	63	65	47	596,506	548	324	+ 69.1	5,101,362	2,895,847	1	....	....	22	23	8	1	2	194	205	130	69	84	63
Missouri	....	....	....	....	....	....	3	2	....	12	15	— 20.0	9,901	15,612	....	....	....	....	....	1	....	....	9	10	8	2	2	3
Montana	11	....	3	31	....	45	22	30	233,255	273	253	+ 7.9	1,327,890	1,348,791	....	....	....	22	22	2	....	....	86	88	99	42	52	43
Nebraska	26	....	....	51	....	77	88	81	466,565	719	568	+ 26.6	4,285,038	3,395,952	3	....	....	30	33	34	....	....	288	322	259	24	33	37
New Mexico	95	....	31	38	2	166	152	174	719,300	1,456	1,659	— 12.2	6,084,575	7,820,232	1	....	6	22	29	31	1	21	166	219	241	166	142	152
Southeast	72	....	2	28	2	104	90	74	471,607	805	832	— 3.3	3,818,666	4,145,430	....	....	1	17	18	22	....	5	123	150	153	97	80	57
Northwest	23	....	29	10	....	62	62	100	247,693	651	827	— 21.3	2,265,909	3,674,802	1	....	5	5	11	9	1	16	43	69	88	69	62	95
New York	10	....	....	2	7	19	19	22	29,400	188	199	— 5.5	298,875	314,344	....	....	....	....	....	....	....	....	....	....	....	25	25	42
North Dakota	12	....	....	8	....	20	25	42	133,901	354	355	— 0.3	2,235,379	2,320,344	....	....	....	2	2	12	....	....	50	62	110	27	20	36
Ohio	55	....	30	29	....	114	99	90	226,149	832	818	+ 1.7	2,157,305	2,106,094	....	....	1	1	2	5	....	4	14	23	7	213	218	228
Oklahoma	194	8	29	151	3	385	379	583	1,551,817	4,686	5,955	— 21.3	17,179,503	18,472,594	2	2	3	41	48	62	12	27	529	630	628	468	467	531
Pennsylvania	20	....	26	7	10	63	59	71	177,469	568	645	— 11.9	1,785,571	1,914,382	....	....	....	1	1	....	....	4	16	20	23	189	177	213
South Dakota	3	....	....	1	....	4	1	1	34,117	15	6	+150.0	99,395	26,804	1	....	....	1	2	3	....	....	6	9	6	2	5	4
Tennessee	....	....	....	....	....	....	....	2	....	38	24	+ 58.3	45,975	30,350	....	....	....	....	....	....	....	....	17	17	9	....	....	....
Texas	825	35	86	538	30	1,514	1,434	1,487	6,686,674	14,836	14,611	+ 1.5	65,495,122	61,767,464	24	1	7	327	359	214	48	80	2,888	3,230	3,391	937	1,029	1,014
Dist. 1: South Central	53	1	....	31	....	85	68	72	216,081	799	817	— 2.2	2,051,307	1,997,099	....	....	....	21	21	7	....	1	247	255	284	39	37	35
Dist. 2: Middle Gulf	22	13	8	34	....	77	56	54	514,407	667	590	+ 13.1	4,180,672	3,599,764	1	....	1	25	27	10	13	12	206	241	209	42	61	30
Dist. 3: Upper Gulf	36	4	2	41	....	83	94	122	533,920	991	1,073	— 7.7	7,052,352	6,885,091	....	....	1	24	25	9	21	8	197	235	297	107	97	93
*Gulf of Mexico	....	....	....	....	....	....	1	2	....	2	11	— 81.8	20,256	86,748	....	....	....	....	....	....	....	1	1	2	9	2	2	....
Dist. 4: Lower Gulf-S.W.	34	16	14	47	1	112	123	60	587,192	1,133	964	+ 17.5	6,119,721	4,997,563	2	1	1	30	34	14	11	10	314	349	390	81	89	59
*Gulf of Mexico	....	....	....	....	....	....	1	....	....	1	7	— 85.7	500	75,300	....	....	....	....	....	....	....	....	1	1	2	....	....	1
Dist. 5: East Central	3	....	3	11	....	17	24	15	68,336	125	166	— 24.7	649,217	610,050	1	....	....	5	6	2	....	1	52	55	96	19	25	11
Dist. 6: Northeast	38	....	9	15	....	62	66	67	342,964	692	695	— 0.4	3,784,812	3,679,147	1	....	....	10	11	10	1	7	125	143	173	57	59	62
Dist. 7-B North Central	85	....	10	117	4	216	207	193	725,493	2,029	1,819	+ 11.5	6,520,993	5,813,339	4	....	2	71	77	55	1	12	601	669	641	104	92	87
Dist. 7-C West Central	28	....	3	34	1	66	67	69	284,996	640	657	— 2.6	2,731,325	3,234,044	3	....	1	27	31	22	....	10	178	210	193	61	68	67
Dist. 8: West	296	....	8	74	12	390	368	359	2,059,269	3,821	3,542	+ 7.9	19,564,153	16,996,077	7	....	1	49	57	51	....	6	425	482	441	243	244	308
Dist. 9: North	154	....	8	101	10	273	244	353	750,193	2,892	3,173	— 8.9	8,087,742	9,034,051	2	....	....	44	46	21	....	2	438	461	548	134	162	169
Dist. 10: Panhandle	76	1	21	33	2	133	117	123	603,823	1,047	1,115	— 6.1	4,752,828	4,921,239	3	....	....	21	24	13	1	11	105	130	119	86	95	93
Utah	8	....	3	5	....	16	24	31	99,879	227	346	— 34.4	1,274,011	1,925,307	1	....	....	3	4	5	....	2	53	60	71	25	34	41
Washington	....	....	....	1	....	1	1	1	6,650	3	6	— 50.0	21,108	33,282	....	....	....	1	1	....	....	....	3	3	5	2	2	1
West Virginia	3	....	61	7	....	71	64	72	178,434	651	692	— 5.9	1,657,674	1,862,663	....	....	....	....	....	....	....	....	1	1	6	213	192	216
Wyoming	34	....	3	53	....	90	57	50	450,222	693	572	+ 21.1	3,610,525	2,699,142	2	....	....	37	39	15	1	8	235	259	178	83	93	118
Others	....	....	....	5	....	5	5	8	15,195	28	31	— 9.7	88,554	142,961	....	....	....	5	5	1	....	1	21	23	18	8	12	4
Total United States	1,987	62	370	1,690	73	4,182	3,968	4,421	17,585,717	40,369	40,542	— 0.4	169,829,339	162,838,093	49	4	30	833	916	586	76	217	7,267	8,146	8,154	4,084	4,227	4,338
Total Western Canada	100	....	25	50	....	175	195	239	875,000	2,046	2,151	— 4.9	10,088,041	10,723,623	....	....	....	....	....	....	....	....	....	....	....	202	184	177

* Gulf of Mexico wells are included in their respective district totals.



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Practical Operating Hints

These How-To-Do-It Ideas Can Save You Money

$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas

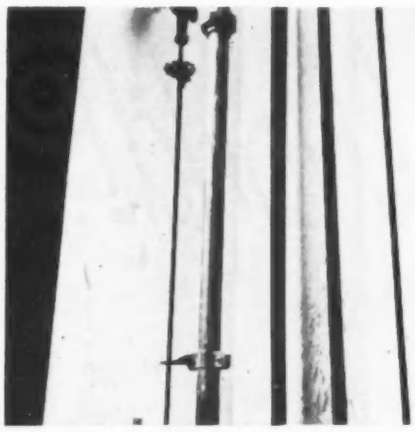
Keep Drilling Report Atop Knowledge Box

Most rigs have their daily drilling report forms thrown into the knowledge box with numerous other forms and an assortment of small tools, parts, etc. However, these are valuable company records and should be neatly made out and copies maintained in useable form at the rig.

One operator took a flat piece of scrap metal, trimmed it neatly and hinged it to the top of the knowledge box, as shown. This did not interfere with the opening and closing of the knowledge box. A long metal bar was fastened through this place to act as a clamp to hold the daily drilling report form in place. The other end of the form was secured in a similar manner, or a large rubber band could be used.

After an entry had been made on the form, the metal plate was swung

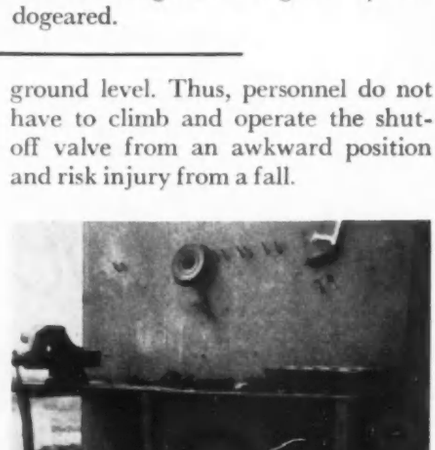
up and out of position and is held in place by a swinging block of wood, or other suitable fastener. This left the top of the knowledge box clear and the report was not thrown in the knowledge box to get dirty and dogeared.



Remote Valve Shut-Off Provides More Safety

As shown, the salt water leg on this gun barrel has a shut-off valve mounted next to the tank which permits the leg to be blocked off whenever it must be removed for cleaning. Rather than mount the valve in an upright or side position, this operator mounted it upside down and made an extended shut-off handle from an old sucker rod.

A guide which provides rigidity for the handle is clamped to the water leg. Manipulation of the handle closes the valve quickly and safely from ground level. Thus, personnel do not have to climb and operate the shut-off valve from an awkward position and risk injury from a fall.



Hook Work Bench to Side Of Skid-Mounted Doghouse

Finding a convenient place to put a work bench for small repair jobs is sometimes a problem around some rigs.

The operator on this Gulf Coast rig hooked the work bench on the side of a skid-mounted doghouse on the rig floor. Three similar inverted L-shaped pieces of angle iron form the legs and the top mount for the work bench.

These three pieces of iron are welded on the end to the side of the doghouse and to the skid on the other end.

A rectangular piece of sheet metal forms the top of the work bench while smaller rectangular pieces of sheet metal connect the legs forming a storage space for tools and parts.

Field-Made Finger Board For Single Joints of Pipe

Junk pieces of 2-, 2½- and 3-inch pipe were used to make this rack for standing single joints of pipe in the workover rig on tubing jobs. The rack folds back when the mast is lowered and is easily extended when on location.

The main body of the frame is made from 2½-inch pipe, beginning with the piece which is clamped to the mast. The pieces which slip over the ends to make the hinges are 3-inch. Two-inch pipe is used to make the guard rail and the frame for the catwalk. The fingers are made from ¾-inch bar stock. A plate is hinged to the end of the catwalk which folds out so that the derrickman can work close to the pipe. The rack is guyed to the top of the derrick and an escape line is attached from one corner to the ground.

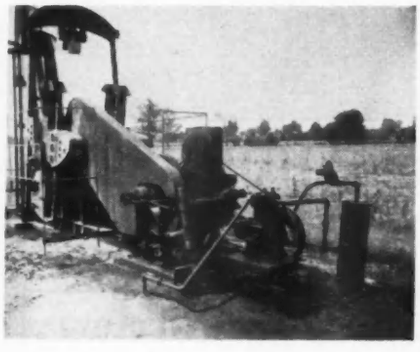
The rack will hold 240 joints of pipe, 10 joints in each row lengthwise and 10 across. This allows well to be serviced to a depth of 7,200 feet without laying down pipe.

More Hints on Page 69

Draining of Lube Made Easy with Jacked-Up Barrel

Quite often a portion of the lube is left in the barrel because of the way the barrel was situated. In order that all of the lube may be removed, a holder as shown is installed on the back portion of the barrel and the barrel is jacked up allowing all the lube to flow to the discharge end.

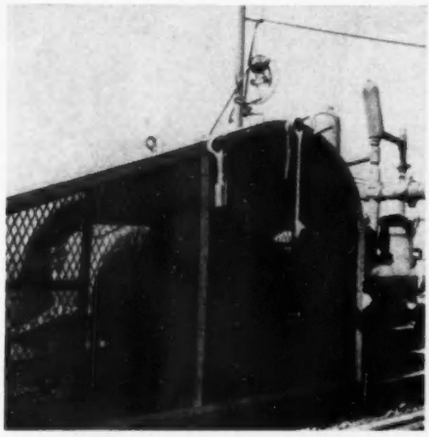
A threaded housing is welded to the cross member of the holder. A threaded crank then works inside the holder and is allowed to move up and down. On the end of the crank a bent piece of stock is welded so that it will conform to the shape of the barrel.



Let Vacuum Pump Provide Pumping Unit Fuel Gas

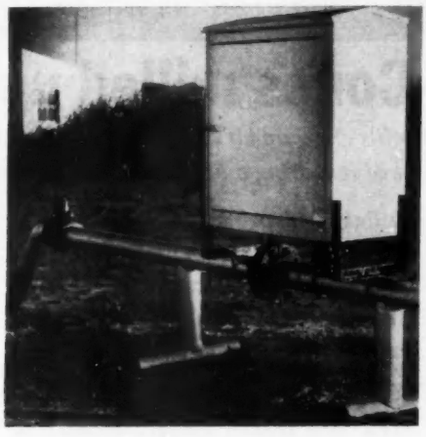
A small vacuum pump, which runs off the pumping unit engine V-belt drive, will provide engine fuel gas in fields where such gas is in short supply. The base of the pumping unit is extended and the pump installed in line with the engines V-belt drive. The inlet to the pump is connected to the casing head and the outlet to a conventional gas scrubber.

The outlet line from the scrubber is connected to the carburetor of the engine and the bottom is connected back into the flow line through a check valve. This maintains sufficient pressure on the scrubber to provide the engine with fuel. Excess gas goes on to the tank battery where it may be trapped and used to fuel other engines or for utility purposes in the tank battery area.



Metal Rods on Belt Guard Keep Lug Wrenches Handy

Small tools around the rig are very costly items. Thus, a drilling contractor has initiated a means of minimizing his losses of lug wrenches. Several ½-inch rods are cut approximately 6- to 8-inches long and are then welded to the pump belt guard. The wrenches are then hung over this rod and are easily accessible when needed to work on the pump.



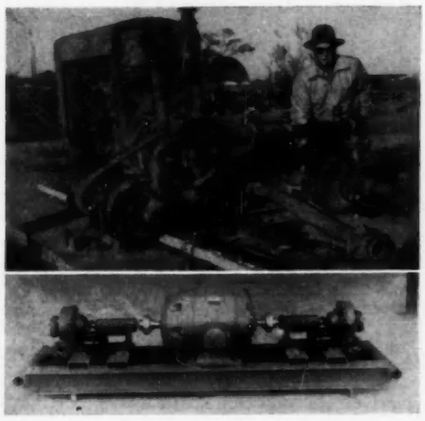
Use Scrap 4-Inch Pipe To Support Meter Run

Scrap sections of 4-inch pipe welded into T-shapes can be used to support field meter run installations. Notch the vertical pieces of the support to conform to the shape of the horizontal run. These supports are cheap and easy to install. No concrete foundation is required.

Mud Jet Inlet Prevents Plugging Mud Pit or Tank

When jetting the settled solids from the bottom of the mud pit or tank, it is necessary to have the jet suction at a point close to the bottom and yet not capable of being plugged.

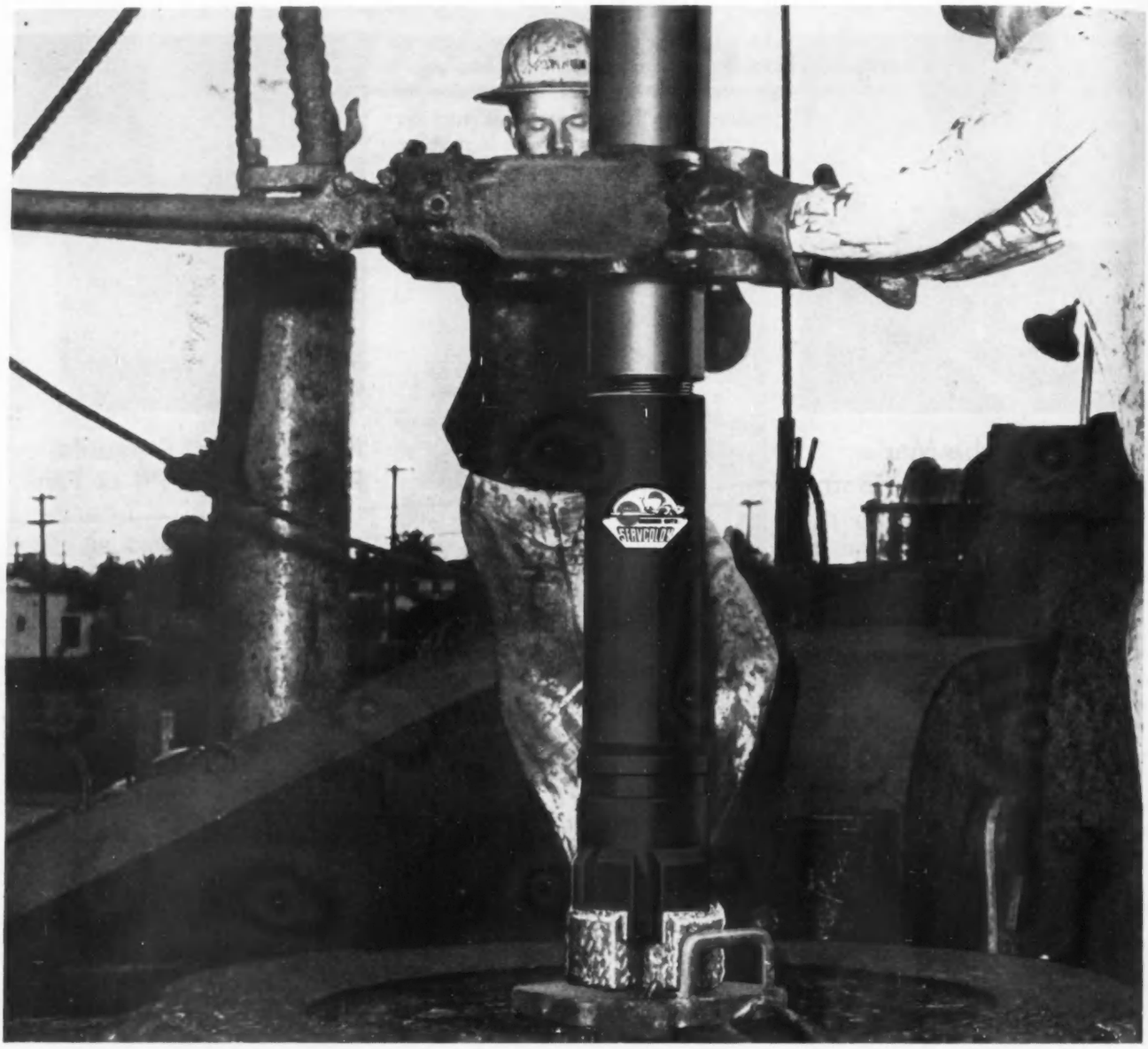
A section of pipe is welded perpendicular to the stand pipe. The ends are then diagonal and left in the configuration as shown. By cutting the ends of the pipe on a diagonal, more inlet area is present and is less likely to plug with drilled solids.



Unique Hook-Up Increases Centrifugal Pump Utility

To maintain interchangeability with other single-stage centrifugal pumps, one operator connected two such pumps in series so that the developed pressures add to give twice the individual pressure. It is possible to use a simple pump design of rugged oil field construction as opposed to a close clearance, expensive multi-stage pump.

A single driver is used in one instance, belt-driving two individual pumps. In another arrangement, a double-shaft electric motor is used to drive gear pumps of opposite rotation.



Three 6⅛" Bit Cones milled up in 2 HOURS!

Servcoloy-dressed Junk Mills chew up bit cones and other junk with amazing speed; makes this method of removing a fish fast, safe, and very economical.

After three cones from a 6⅛" bit were left on bottom, two rock bits, two hydro-bailers, and two junk baskets were run during a three-day period in attempts to either recover or sidetrack the three cones. Results were negative.

A six-inch Servco CJ Junk Mill dressed with Servcoloy, was then run in the hole. A total of two feet of hole was drilled in a period of two hours of milling. The operator ran back with a bit and proceeded to drill a head. Fine steel cuttings were caught on the shaker during the milling and appeared on the mud screen during the succeeding day, showing that the *cones were actually milled up, not sidetracked.*

Other operators running the Servco Junk Mill report similar results. The astonishing cutting properties of Servcoloy have completely changed thinking about down-hole milling. Why not get complete information from your nearest Servco office?

WHAT IS SERVCOLOY?*

Servcoloy is a patented, hard-facing material which uses a unique method of suspending bits of carbide in a tough, elastic matrix. As the carbide cutting edges are worn away or torn from the matrix, new edges are automatically exposed. Servcoloy is now being used on Servco milling tools such as section mills, rotary shoes, taper mills, pilot mills, etc. Remedial work which formerly took days to do is now being done in hours.

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*U.S. Patent No. 2,833,638

How to cut sour gas well completion costs

Using calculated data and temperature surveys, engineers can predict whether down-hole freezing will occur. Savings average $16,000 per job when results indicate hydrate control equipment is not required

By Keith N. Wallam and Vincent P. Milo
Chemical Engineers
Shell Oil Company of Canada, Ltd.
Calgary

USING CALCULATED hydrate curves and down-the-hole temperature surveys, Shell Oil Company of Canada has been able to predict the subsurface hydrate problem in sour gas wells. These surveys also permit determination of the efficiency of a particular hydrate-control system. In many cases, well completion costs have been reduced as much as $16,000 because it was discovered that hydrate-control equipment was not required. A possible additional saving of $30,000 can be made by reducing casing size from 7-inch to 5½-inch when no 5-inch circulating string is required.

Shell first discovered sour gas-condensate in Canada in the early 1940s at Jumping Pound, Alberta. The wells were completed in the Mississippian limestone at approximately 10,000 feet, with 7-inch production casing—2⅞-inch tubing annulus packed off and filled with mud. The production contained approximately 4 percent hydrogen sulphide.

Attempts to open and flow these wells resulted in "freezing" due to the formation of solid hydrate plugs in the tubing between the surface and 3,000 feet. It was found that hydrate plugging could be prevented by hanging a circulating string of 5-inch casing at 3,500 feet, and pumping hot diesel oil down the 2⅞-inch - 5-inch annulus and returning it to surface via the 5-inch - 7-inch annulus (Figure 1). Therefore, the original wells were worked over and all new wells were completed with 5-inch circulating strings.

Circulating Strings. The first circulating strings used were designed on the basis of previous experience obtained in the United States. The completion consisted of 7-inch casing and 2½-inch tubing to total depth,

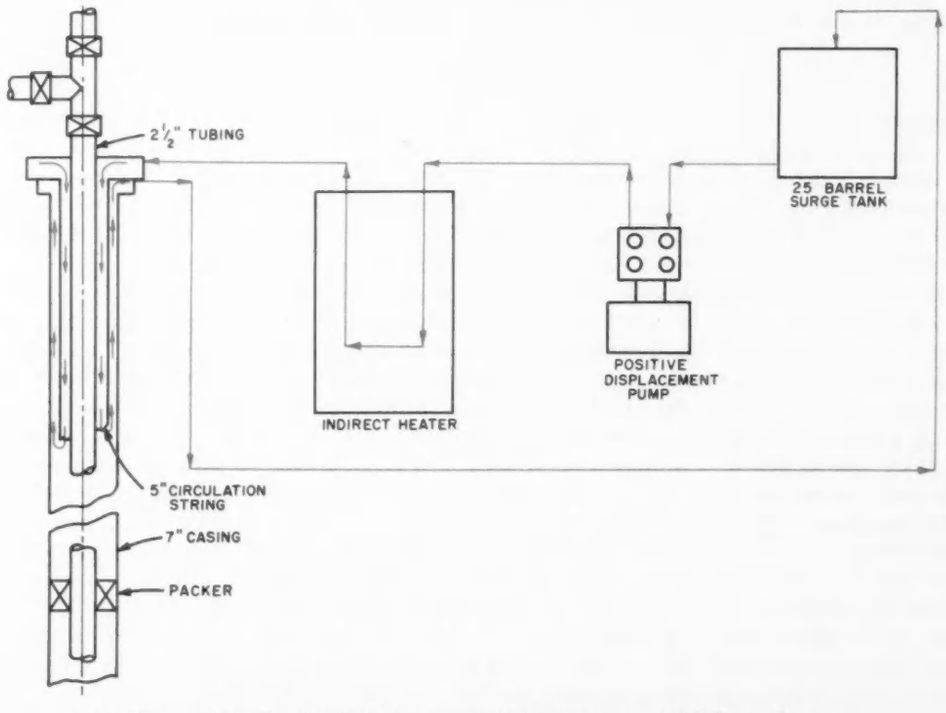

FIGURE 1—Hot oil circulating systems of this type were initially used to prevent downhole hydrate plugging of sour gas wells in Canada.

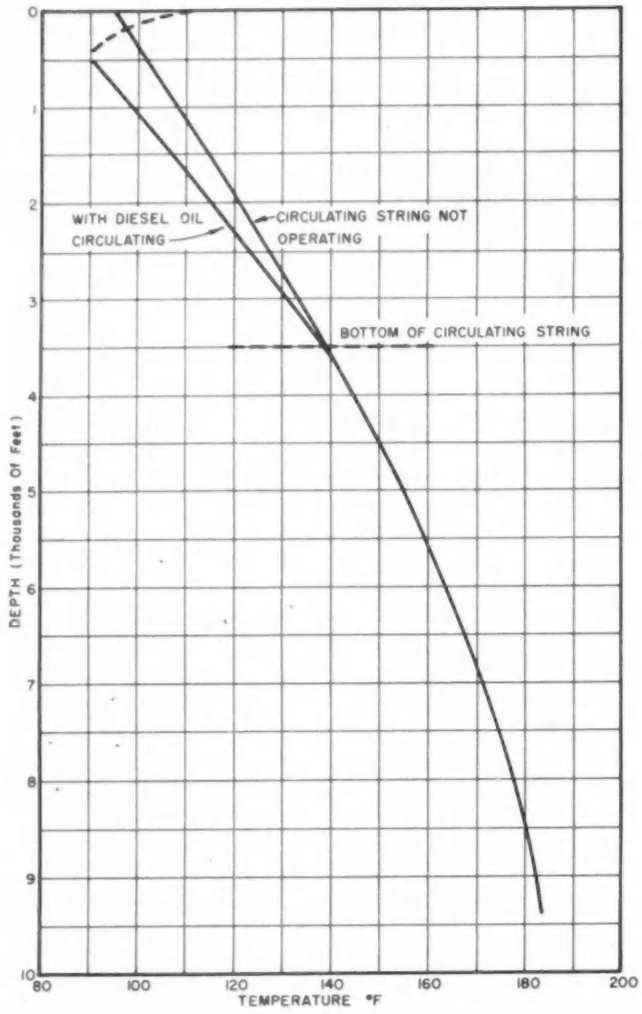

FIGURE 2—These temperature-depth curves, plotted for Jumping Pound 1 flowing at a rate of 2.7 MMcf/d, indicate the ineffectiveness of circulating strings when diesel oil is used as the circulating medium. Note that almost all of the tubing was actually being cooled by the circulating diesel oil.

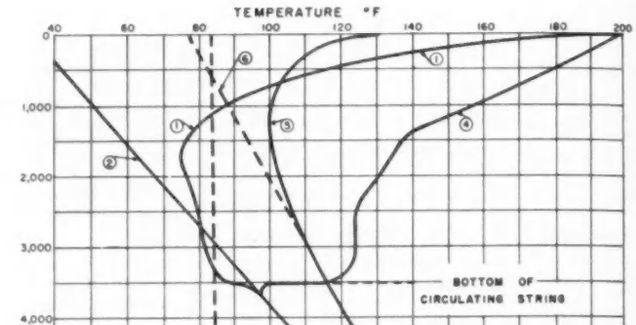

FIGURE 3—This set of curves shows the effect of different circulating media on tubing temperatures. Note that use of high flash oil relieves the danger of hydrate formation.

with the annulus packed off and filled with mud. The 5-inch circulating string was hung free to 3,500 feet.

Diesel oil heated to 160° F was circulated at 60 bph down the 5-inch - 2½-inch annulus, and returned up the 5-inch - 7-inch annulus. The oil was heated by a water-bath, gas-fired, 250,000 Btu indirect heater. Figure 2 shows the effect that this type of circulating string had on the tubing temperature gradient at Jumping Pound 1 with the well flowing 2.7 MMcf/d.

Tubing head temperature indicated that the gas was being heated from 95° F, with the circulating string shut-in, to 110° F with the circulating string operating. Actually, however, all but the top 200 feet of the tubing was being cooled by the circulating oil. In fact, gas temperature was lowered as much as five degrees.

This was probably due to a considerable amount of heat being lost from the hot inlet oil to the return oil, and thence to the formation. Because of this heat loss, these circulating strings were grossly inefficient, and in effect only 10 to 20 percent of the heat loss by the oil was transferred to the gas in the tubing. It was reasoned that if a higher heat capacity medium were circulated then the heat transfer to the gas in the tubing would be increased.

In the next well, located in the Okotoks field, inhibited water was used as the circulating medium. Because of the higher hydrogen sulphide content of Okotoks wells, the hydrate-formation temperature is higher than at Jumping Pound, and the problem is more severe. Water at a temperature of 166° F was circulated at 30 bph. Curve 1 in Figure 3 shows that with the well shut-in, the tubing-temperature profile was not raised above the hydrate temperature and there would have been a danger of "freezing" and plugging the tubing if the well had been opened up at that time.

Next, the circulating-medium temperature was increased. This was done by using a high-flash point absorption oil instead of diesel oil in the circulating string. The temperature of this oil can be safely raised above 200° F. This was accomplished by using an oil bath in the heater.

Curve 4, Figure 3, shows the tubing-temperature profile with the well shut-in and the circulating string operating on high flash oil. Comparing this with the geothermal gradient (Curve 2) and the hydrate-formation temperature (Curve 3), it can be seen that any danger of hydrate formation during start-up has been eliminated.

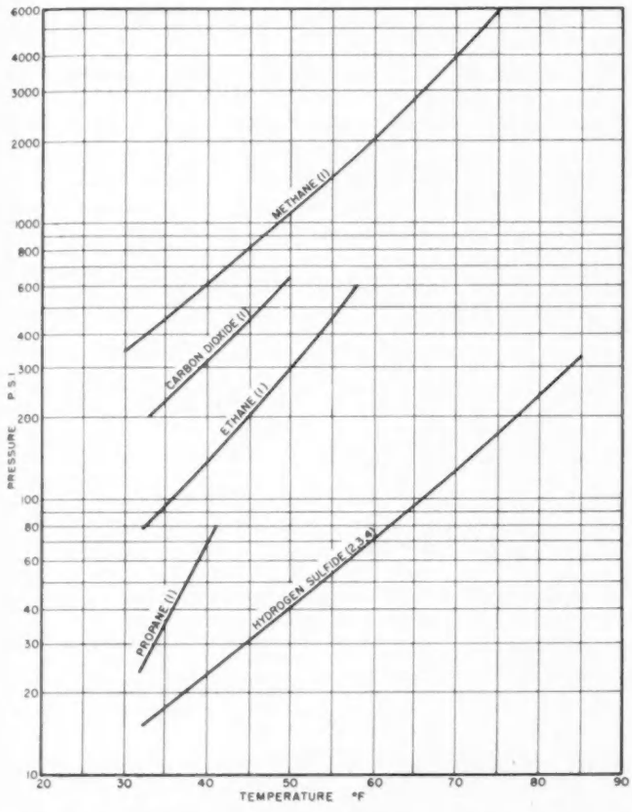

FIGURE 4—Conditions under which gases found in varying amounts in gas well streams will form hydrates, can be determined from this set of curves. For a given pressure, gases such as CO_2 and H_2S (found in considerable concentration in sour gas condensate wells) form hydrates at much higher temperatures than hydrocarbon gases. This explains the increased hydrate problem in sour gas wells.

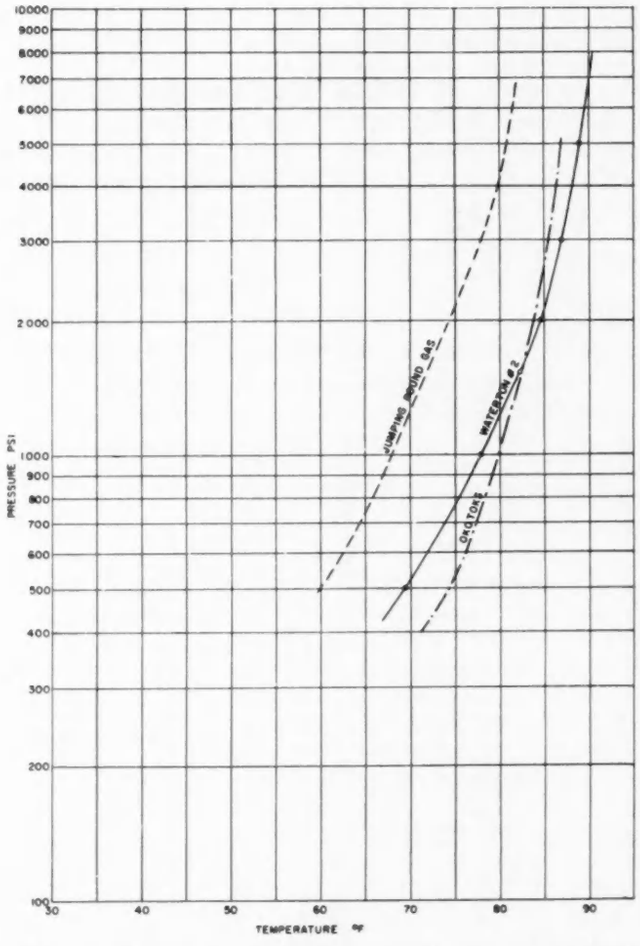

FIGURE 5—Here are hydrate curves for gases produced from three different Canadian fields. Accuracy of these calculated curves has been proven by experience. Note that hydrate formation temperatures for Waterton gas are about 10° F higher than those for Jumping Pound gas at corresponding pressures. This is due to the high acid gas content of Waterton production (Table 2). Okotoks gas exhibits still higher values for the same reason.

The next thing checked was the effect of hot-oil circulation on the flowing temperatures. Curve 6 shows that with the well flowing 2.5 MMcf/d, and the circulating string shut-in, the tubing head temperature is approximately five degrees below the hydrate temperature of the gas, and there is no subsurface cooling of the gas in the tubing.

It was found that surface temperatures are not a true indication as to whether the circulating string is operating effectively. For a 3,000 to 3,500-foot circulating string, optimum design requires the circulation of high-flash oil at 35 bph and 180° F. Experience has shown that a shorter circulating string, perhaps 500 feet less than that indicated by the intersection of the geothermal gradient and the hydrate curve, can be used successfully. The effect of dynamics during the start-up period has not yet been evaluated.

High flow rate start-up. Experience was to show that Jumping Pound wells could be flowed without circulating hot oil once the well had "warmed up" and stabilized. It also was discovered that these wells could be opened by an experienced operator, without circulating hot oil, by a method known as the high flow rate start-up technique.

Briefly, this technique consists of opening a well at a high flow rate to bring formation heat up the hole to warm the tubing as rapidly as possible. By observing the tubing-head temperature during this period, and "stop-cocking" the well should the temperature start dropping rapidly indicating "freezing" and hydrate plugging, an experienced operator can open a well without trouble. When wellhead temperature stabilizes above the calculated hydrate-formation temperature of the production, the operation is complete.

Since conservation prevents wasteful flaring of gas during start-up, and since it is not always possible to open a well into the gathering system at a high rate, it is not always possible to apply the high flow rate start-up technique. Therefore, attention was devoted to an investigation of the hydrate plugging problem with a view to predicting the hydrate-control requirements of new discoveries.

This prediction was to be based on a knowledge of geothermal gradients and gas analyses obtained either on drill stem tests, or during the initial completion of the discovery well. The tests also proved valuable in determining the thermal efficiency of the hot oil circulating string since an annulus filled with high flash point oil repre-

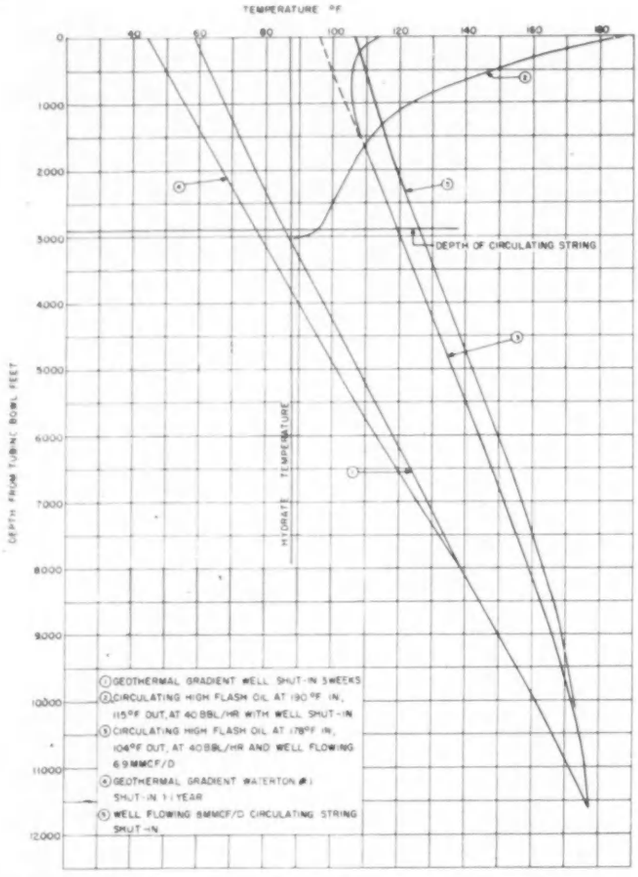
TEMPERATURE °F
DEPTH FROM TURNC BOWL FEET
DEPTH OF CIRCULATING STRING
HYDRATE TEMPERATURE
① GEOTHERMAL GRADIENT WELL SHUT-IN 5 WEEKS
② CIRCULATING HIGH FLASH OIL AT 190°F IN, 115°F OUT, AT 40 BBL/HR WITH WELL SHUT-IN
③ CIRCULATING HIGH FLASH OIL AT 178°F IN, 104°F OUT, AT 40 BBL/HR AND WELL FLOWING 6.9 MMCF/D
④ GEOTHERMAL GRADIENT WATERTON #1 SHUT-IN 1 1 YEAR
⑤ WELL FLOWING 6MMCF/D CIRCULATING STRING SHUT-IN

FIGURE 6—These tubing temperature plots were obtained during hydrate testing of Waterton 2. It is apparent from Curve 5 that the well can be produced at reasonable rates without hydrate difficulty if the high flow rate start-up technique is used.

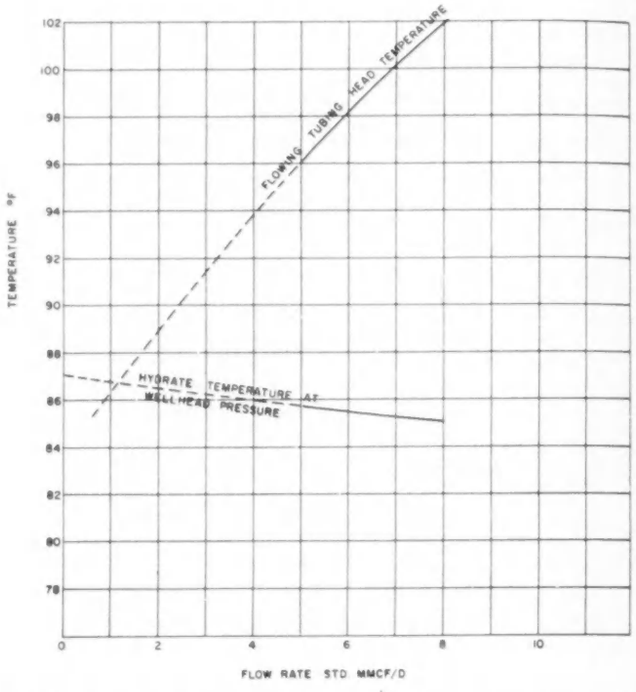

FIGURE 7—This well (Waterton 2) can be expected to flow at rates as low as 4 MMcf/d without difficulty. For example, at the 4 MMcf/d rate, flowing tubing head temperature is about 94° F and hydrate formation temperature at well pressure is 86° F. Thus, the normal flowing temperature is 8° F higher than the hydrate temperature and safe operation is assured.

sents considerable capital investment, up to $4,000 per well (see preceding section on Circulating Strings).

Discovery of the Devonian Okotoks reservoir increased the value of these efforts. In the Okotoks field, sour gas production containing 35 percent hydrogen sulfide was obtained from approximately 8,500 feet. As indicated previously, these wells could not be produced successfully, even when using the hot oil circulating string.

Hydrate curves. Hydrates are solid compounds formed by the reaction of gases with liquid water under definite conditions of high pressure and low temperature (Figure 4). Katz and coworkers[5, 6, 7] discovered that hydrate formation followed the rules of solid-vapor phase equilibrium and measured the equilibrium constants for methane, ethane, propane, isobutane, hydrogen sulphide and carbon dioxide. Normal butane and heavier hydrocarbons do not form hydrates. Using these equilibrium constants, a hydrate curve may be calculated for any given gas analysis. A sample calculation is given in Table 1, and Table 2 lists the gas analyses for the fields discussed herein.

Figure 5 shows hydrate curves calculated from these analyses. The hydrate curve provides the basic information necessary to determine the probable extent of the hydrate problem for any given well.

Standard start-up procedure. Experience in several gas fields has shown that hydrate problems are most severe at start-up and low flow rates. Very little is known about a new discovery well until after the initial production test. Often, this is the most critical time for hydrate formation since large amounts of water usually are produced during the well "clean-up" period that follows acidizing.

The following start-up procedure has been adopted by Shell:

(a) The gas analysis is obtained from the drill stem test. If this is not possible, the analysis is estimated. The hydrate curve for this gas analysis then is calculated.

(b) The geothermal temperature gradient is measured, or an applicable

TABLE 1—Sample Calculation of Hydrate Formation Condition

Waterton Gas		Pressure 1,000 psi	
Assumed Temperature 78° F*			
Component	Mol. Frac.	Equilibrium Constant	
	y	k	y/k
H_2S	0.3154	0.532	0.592
CO_2	0.0861	.....	0
C_1	0.5151	1.32	0.391
C_2	0.0280	1.85	0.015
C_3	0.0094	.....	0
iC_4	0.0014	0.58	0.002
Total			1.000

At 1,000 psi hydrate formation temperature is 78° F.
* Trial calculations are made to determine the temperature at which the sum of y/k equals 1 for the selected pressure.

TABLE 2—Gas Analyses for Fields in Which the Hydrate Control Method Has Been Applied

(Mole Percent)

Component	Jumping Pound	Okotoks	Waterton
H_2S	4.02	32.00	31.54
CO_2	4.90	10.19	8.61
N_2	1.49	3.66	2.42
C_1	84.63	52.79	51.51
C_2	2.19	0.67	2.80
C_3	0.89	0.20	0.94
iC_4	0.27	0.03	0.14
C_4	0.35	0.05	0.35
C_5†	1.17	.41	1.69

generalized curve is used for gradient determinations.

(c) The bottomhole and surface shut-in pressures, and the corresponding hydrate-formation temperatures are estimated.

(d) The geothermal gradient and hydrate temperature curves are plotted. The intersection of these curves gives the maximum depth to which hydrate control will be required.

(e) The well completion is designed to include running a circulating string to this depth.

When the well has been completed the following data are obtained:

1. The tubing temperature profile with both the well and the circulating string shut-in. This should confirm the geothermal gradient used in (b) above.

2. The tubing temperature profile with the well shut-in and the circulating string operating. This will indicate if the circulating system is maintaining the tubing temperature above the hydrate temperature at all points before starting up the well.

3. The tubing temperature profile with the well flowing and the circulating string operating, after the wellhead temperature has stabilized.

When this data has been obtained, the following procedure is applied:

- From (3), estimate if the wellhead temperature will be above the hydrate temperature if the circulating string is shut down.

- The flowing tubing head temperature and the calculated hydrate temperature are plotted versus the well flow rate. The latter plot is obtained from the tubing head pressure for each flow rate. The intersection of these curves is the minimum flow rate at which the well may be flowed without hydrate control.

- Without operating the circulating string, and after the well has been shut in long enough to allow the tubing to cool to the geothermal gradient, an attempt should be made to start the well by the high flow rate technique.

EXAMPLE APPLICATION

The following discussion shows how the previously described method was applied at a new sour gas-condensate well. It was shown that subsurface hydrate-control equipment was not required.

Test equipment and procedure. To determine the tubing temperature profile under varying well conditions, and predict the probable hydrate control problem, a number of temperature surveys were run.

Waterton 2 was completed with a 2,960-foot 5-inch circulating string, and high-flash oil was pumped from a 25-barrel surge tank through two indirect heaters in which oil was being used as the heat-transfer medium. By maintaining the shell side at 300° F it was possible to maintain the tube side at 180° F while circulating at rates up to 40 bph.

Results. An analysis was obtained on a gas sample obtained from Waterton 2, and the hydrate curve was calculated by the Carson & Katz method. This hydrate curve is shown in Figure 5.

To determine the tubing temperature profile at the instant of cold start-up, a temperature survey was run before opening either the hot oil circulating string or the well (Curve 1, Figure 6). The well had been shut-in for three weeks prior to running this survey. The recorded surface temperature of 60° F was higher than normal, which indicated that the well probably had not cooled to equilibrium with the geothermal gradient.

A tubing temperature survey was run in Waterton 1, and plotted as Curve 4, Figure 6. Waterton 1 had been shut-in approximately one year at the time of this survey. Comparison of curves 1 and 4 confirmed that Waterton 2 had not reached equilibrium during its three-week shut-in period prior.

Curve 1, Figure 6, intersects the hydrate curve at approximately 3,100 feet. Therefore, at the time of the survey the upper 3,100 feet of tubing in Waterton 2 were under hydrate-formation conditions. The upper 3,800 feet of tubing in Waterton 1 are under hydrate-formation conditions at the instant of cold start-up. After a prolonged shut-in period, this also probably would hold true for Waterton 2.

Curve 2, Figure 6, shows the effect of circulating hot oil with well shut in. The complete tubing string was above the hydrate temperature, and no difficulty was encountered in starting up the well. Note that the inlet and outlet annulus oil temperatures reached equilibrium after only a few hours circulation.

Curve 3, in Figure 6, shows the stabilized tubing temperature profile while flowing 6.9 MMcf/d with the

TABLE 3—Time-Temperature Relationship During Start-Up of Waterton 2

Time	Tubing Head Temp.	Heater Press.	Inlet Temp.	Choke	Remarks
3:53P	Open Well				Circulating String.
3:54	Broken		76	25/64	Shut-in, well has been shut-in 12 days.
3:56		2,500	56		
3:58		2,520	56	20/64	Shut-in Pressure 2,700 psi.
4:00		2,500	56		
4:02		2,500	58		
4:04		2,500	59		
4:06		2,470	61		
4:10		2,420	64	26/64	
4:13		2,300	66		
4:15		2,260	66		
4:20		2,250	78	32/64	
4:30	84	2,250	81		
4:32		2,050	80	38/64	
4:35	82	1,850	78	45/64	
4:39		1,700	77	49/64	
4:40	82	1,650	76		
4:45		1,625	78		
5:00	86	1,600	81		
5:05	92	2,000	87	32/64	Turn through separator.
5:08	98	2,380	95	26/64	
5:15	98	2,450	95.5		8.8 MMcf
5:30	94	2,480	93	24/64	7.7 MMcf
5:32		2,520	94		
5:45	95	2,510	93		Flow interrupted for corrosion testing.
7:00	97	2,510	95		
8:00	99	2,510	98		

circulating string operating. Gas temperature was above the hydrate temperature throughout the tubing. The projected (dotted) portion of this curve indicates that only the upper 1,500 feet of the circulating string was effective at this flow rate. This projection also indicates that even with the circulating string shut-in, the stabilized flowing gas temperature could be expected to be above the hydrate temperature throughout the tubing string.

Only two hours were required for the tubing temperature profile to move from Curve 1 to Curve 3 (Figure 6) during the start-up. Also, since only a small volume of water was produced during this period, it appeared highly probable that the well could be started up by the high flow rate technique with the circulating string shut-in.

This theory was confirmed after a shut-in period of two weeks when the well was started without difficulty at rates of 8 to 10 MMcf/d and without using the circulating string. Table 3 shows the time-temperature relation during this start-up test. In 75 minutes the tubing head temperature was raised above the hydrate formation temperature. Curve 5 of Figure 6 shows the results of a tubing temperature survey made with the well flowing 8 MMcf/d, and the circulating string still shut-in. The gas temperature was above the hydrate temperature throughout the tubing string.

Tubing head temperature was recorded at each point of stabilized flow obtained during a multi-point potential test (Figure 7). For comparison, the hydrate formation temperature at well head pressure is plotted for the same flow rates. Extrapolating these data indicates that at some low flow rate, probably less than 2 MMcf/d, the tubing head temperature of the gas will drop to the hydrate formation temperature. At flow rates as low as 4MMcf/d, there is sufficient difference (about 8° F) between the flowing tubing head temperature and the hydrate formation temperature to prevent hydrate formation in the tubing.

If Waterton 2 can be considered representative of the reservoir, then no down-hole hydrate control equipment need be installed in future wells in this field. Immediate savings of approximately $10,000 per well in completion costs can be anticipated. A saving of approximately $6,000 per well for future surface equipment can also be expected when a gathering system is installed.

ACKNOWLEDGMENT

The authors acknowledge the help of the many field personnel who assisted in the collection of data and wish to thank Shell Oil Company of Canada for permission to publish this report.

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—The End

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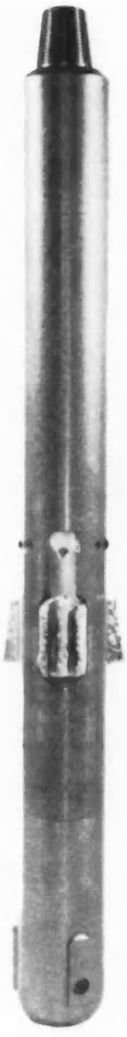


FIGURE 1

FIGURE 2

FIGURE 3

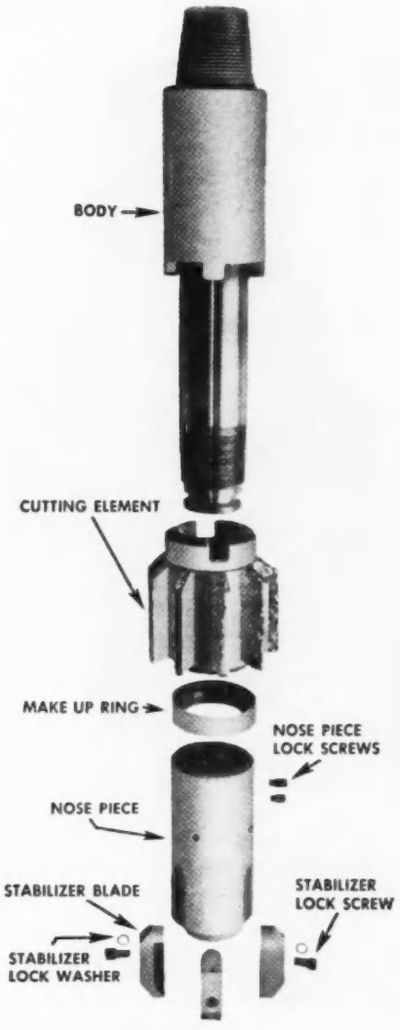


FIGURE 4

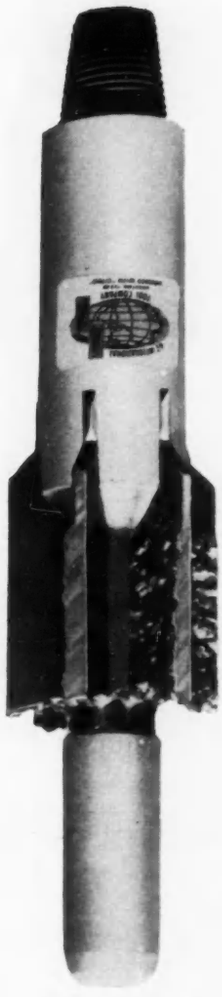


FIGURE 5

FIGURE 1—Section mill is used to mill away a section 25-30 feet in length, usually for sidetracking. FIGURE 2—Pilot mill is used to mill screens, liners, casing or stuck wash pipe. FIGURE 3—Pilot mill is especially good for export as one tool may be ordered with many extra cutting elements. FIGURE 4—Breakdown of pilot mill elements. FIGURE 5—Drill pipe mill.

Are milling tools being used properly?

Each operation requires a special design tool for maximum efficiency

Jack Chadderdon, President
A-Z International Tool Co.
Houston

FRAGMENTED TUNGSTEN carbide mills have reached general acceptance by industry; however, considerable skepticism still exists toward this new method of milling due to lack of understanding of the tools and their application. Poorly designed tools run by operators inexperienced with a new type of milling tool can produce dismal results.

There can be several reasons for poor results on any one job; however, on far too many jobs results can be directly traced to inferior tools run by personnel unfamiliar with fragmented tungsten carbide mills. On the other hand, because fragmented tungsten carbide milling is relatively new, the oil operator lacks information on what to expect from properly designed and properly run milling tools; so judging results is difficult.

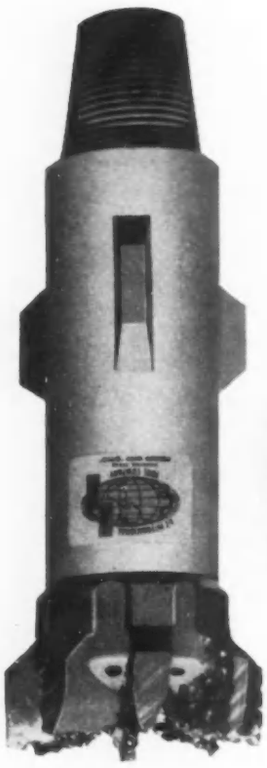


FIGURE 6

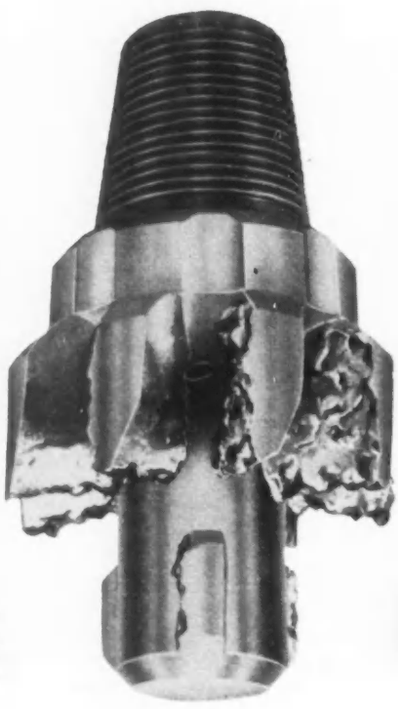


FIGURE 7

FIGURE 8

FIGURE 9

FIGURE 6—Drill collar mill. FIGURES 7 and 8—These mills were designed to drill packers and bridge plugs using tubing as the drilling string. FIGURE 9—A junk mill.

It is thought that all that is necessary to make a fragmented tungsten carbide mill is to:

- Break up tungsten carbide into small pieces.
- Braze these pieces together in some form of welding rod.
- Braze the welding rod material to a mill body.
- Run the mill in the hole and start cutting.

There is more to it than that. A number of mills of this type are being run, and it is only natural that operators who have experienced the results of this type of milling conclude that fragmented tungsten carbide mills have been too highly touted. Even worse, some operators have unnecessarily gone through the experience of having mills walk through the casing string on what should have been a simple junk milling or washover job.

Fragmented tungsten carbide mills are no "cure-all." Neither should they be considered "last resort" tools. Proper planning, good design and operation will produce in most cases the desired results.

Since tungsten carbide has been used for years in the oil field, what is so new and different about the present milling tools? Briefly, there are a great number of manufacturers, types and grades of tungsten carbide. For example, one of the first uses of tungsten carbide on a down hole tool was on the fish tail bit. Small "slugs" of tungsten carbide were welded to slots along the cutting edge to prolong bit life. This type of tungsten carbide, however, is utterly useless for cutting steel down hole.

Several attempts have been made to utilize the excellent cutting qualities of cemented tungsten carbide—a powdered metallurgy product—on inside cutters, outside cutters and down hole milling tools. However, because cemented tungsten carbide is sensitive to mechanical as well as thermal shock, the results were so poor that many development projects were abandoned. At that time, no one considered cushioning fragments of tungsten carbide in a matrix material as is now done and arranging fragments in a wear away pattern so that numerous cutting elements could be utilized on one trip in the hole.

What is a good mill? A good mill is tailor made for different grades of steel and conditions. Although a milling tool is a simple looking piece of equipment, there are some reasonably complex metallurgical combinations involved if optimum results are to be obtained.

Following is a general description of different types of milling jobs encountered and the results to be expected if properly designed mills are used. These results are based on using conventional drilling equipment and

FIGURE 10

FIGURE 11

FIGURE 12

FIGURE 10—Used to mill tubing cemented inside of casing. FIGURE 11—Taper mills are successful in milling collapsed sections of casing. FIGURE 12—Full gage reamer mill.

practices. Equipment and conditions necessary for best milling results:

- Drill pipe.
- Drill collars—8,000 to 20,000 pounds on bottom.
- Stabilizers—usually two, dressed to ⅛ to ¼-inch under ID of hole or casing, are sufficient.
- Pump and mud program sufficient to remove cuttings from the hole under normal drilling conditions.
- Rotary table capable of speeds of 150 rpm.

Section milling. Milling a section involves milling a 25 to 30-foot section of casing usually for side tracking purposes. Results to expect:

- At least 90 percent of the time, a 25-30 foot section should be cut with one set of cutters (one trip in the hole).
- Initial cut through should take from ¾ to 1½ hours.
- Milling rates should be from 3 to 5 feet per hour.
- These rates include S-95 and P-110 grades of casing.

Remarks:

A section mill (Figure 1) is a simple, hydraulically actuated tool in which the cutter arms cut through and are opened into milling position by internal pressure developed by the pressure loss of fluid across an orifice. Casing collars can be located and the cutter arms open sufficiently to mill away collars if necessary.

Drill collar weights in the neighborhood of 8,000 pounds are desirable.

Pump pressures will vary as to the size of drill pipe, mud weight, etc.; however, generally 1,200 psi would be required at 7,000 feet depth and would increase to 2,200 psi at 14,000 feet.

Occasionally, the bottom joint or two of casing in a string of surface pipe will part or be knocked loose from the surface string while drilling out. These casing joints can be milled at a rate of 2 to 4 feet an hour. Down hole conditions will determine the number of trips required as it is sometimes necessary to chase the fish down hole before it becomes wedged for milling.

Milling screens, liners, casing, stuck washpipe. Results to expect:

- If milling is done in open hole, rates will vary from 4 to 15 feet per hour with an over-all average of 5 to 6 feet per hour when milling N-80 and P-110 grades.
- Average footage per mill should be about 100 feet.
- If milling is done inside casing, results will vary considerably, depending on the relationship of the fish and the ID of the casing. Over-all averages approximate 3 feet per hour with mill life expectancy of 50 feet.

Figure 2 illustrates the basic design of a pilot mill. Depending on down hole conditions, mill design should be varied. When desirable, the pilot can be dressed to clean out the ID of the fish ahead of the cutting blades of the pilot mill. In directional holes or washouts where there is danger of sidetracking, extensions may be run below the pilot.

Figures 3 and 4 illustrate a pilot mill which is advantageous for export as one tool may be ordered with extra cutting elements. Thus, a considerable inventory saving can result. In addition, cutting elements and stabilizing blades can be ordered for adapting the mill to more than one size casing. Operation of this type of mill is identical with that of the standard pilot mill.

If good mud and proper hydraulic conditions exist, most of the metal cutting can be recovered. These cuttings should be removed from the mud system by means of a shaker or some method of screening if a shaker is not available. Some operators place bar magnets in the mud ditch on the down side of the shaker to remove the small metal particles that will pass through the shaker screen.

The importance of the recovery of shavings naturally varies. Many sections have been milled with salt water with no cuttings recovered. Liners and screens have been milled under "lost return" conditions. The importance of recovering shavings depends on subsequent operation, and their recovery is directly proportional to the efficiency of the mud and hydraulic system.

Pilot milling is becoming a "planning type" of tool rather than a "last resort" tool as the cost compares favorably with the cost of other recovery methods.

Split and collapsed casing, as well as split and ragged tops, will seriously retard milling footage. Sidetracking in open hole sometimes can be a prob-

lem; however, properly placed extensions will minimize this problem.

Milling drill pipe and drill collars. Figure 5 illustrates the drill pipe mill and Figure 6, the drill collar mill. Results to expect:

Milling drill pipe.

- The body of the drill pipe can be milled at rates of from 3 to 6 feet per hour. Tool joints take from 1 to 2 hours.
- Each mill should mill one complete tool joint and 30 feet of drill pipe.
- These rates include Grade D and E drill pipe and AISI 4142 (or equivalent) heat treated tool joints with a hardness range of 285-320 Brinell.

Milling drill collars.

- Few drill collars above 5¾-inch OD have been milled so no expected footage remarks can be made on larger sizes. Development work is in process that should improve present footage results. Drill collars with 3¾-inch through 5¾-inch OD can be milled at rates from 6 inches to 1½ feet per hour.
- Mill life should be from 10 to 15 feet.
- These rates apply to a fully heat treated alloy steel drill collar—AISI 4142 or equivalent).

The economics of milling drill pipe and drill collars versus other methods of recovery are poor. However, on occasion drill pipe or drill collars are backed off, leaving a portion inside the stuck washpipe or inside casing above the casing shoe. At such a time, it becomes economical to mill.

Milling packers, bridge plugs and cement. The packer bit (Figures 7 and 8) was designed to drill packers and bridge plugs using tubing. Drill collars above the mill are desirable, but not necessary, but a rotary table is necessary as power tongs do not develop sufficient speeds for successful milling.

Results to expect (drilling with tubing only):

- Production packer can be drilled in 5 to 7 hours.
- Bridge plugs can be drilled in 1 to 2 hours.
- Cement can be drilled at rates of 4 to 10 feet per hour.
- A packer bit should drill one packer and a quantity of cement or two bridge plugs and a quantity of cement. These are minimum requirements as a number of packer bits have drilled two packers and varying footage of cement.

Results to expect (with drill pipe and drill collars):

- Production packers can be drilled in 3 to 4 hours.
- Bridge plugs can be drilled in 15 minutes and cement at rates of 7 to 15 feet per hour.

The packer bit is similar in appearance to the junk mill; however, it illustrates the differences that must exist between mills to perform properly. Production packers and bridge plugs are manufactured from softer materials than that usually encountered down hole. The packer bit will drill this material much more efficiently than the junk mill. On the other hand, the junk mill is a much more rugged mill and will perform under conditions that would be wholly unsuited for the packer bit.

Milling junk. The junk mill (Figure 9) is one of the most versatile and rugged mills; however, it is a difficult mill on which to be specific because of the wide variety of fish and down hole conditions encountered. It is often a "last resort" tool and some of the jobs it has performed have been phenomenal and some of them have been disappointing. It has and will mill bits, bit cones, reamer cones, tubing, cemented tubing and drill pipe, packers, cement, bridge plugs, hammers, tong and tong dies, etc., with varying degrees of success.

It also has been used for side tracking liners and drill collars.

This mill, properly designed, is capable of withstanding spudding, heavy weights and fast rotational speeds.

Milling cemented tubing. Tubing cemented inside of casing usually results in a difficult clean out job since it seldom remains in the center of the hole.

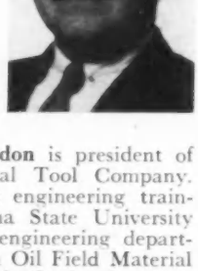
Cemented tubing cannot be milled with a pilot mill. A junk mill will mill at rates of 2 to 4 feet per hour as long as the tubing is in the center of the hole. When the tubing is alongside the casing wall, a core hole is worn in the center of the junk mill due to one wall of the tubing being on the dead center of the mill. When this condition exists, the junk mill will not cut; so a special mill is used (Figure 10).

In the event the tubing is alongside the casing wall, this above special mill will cut a core from the wall of the tubing that is on the approximate center of the hole. As the core moves up into the center of the mill body, it is progressively milled away by three core cutters. As additional footage is made, the position of the tubing may change from alongside the casing wall to the center of the hole; the mill will continue to cut as a junk mill, but will no longer cut a steel core.

Milling collapsed casing. Taper mills (Figure 11) are successful in milling collapsed sections of casing. The number of mills necessary depends on the condition of the section. It is not good practice to run one full gage mill into a thoroughly collapsed section as the hole could possibly be side tracked. It is better to progressively open up a section using two to three taper mills, starting with a small mill and increasing the diameter until a full gage mill can be run safely.

Occasionally, a sliver will exist in a milled out collapsed section that will bend away from the taper mill and spring back when the mill has passed. One way to eliminate this condition is to run a full gage reamer mill (Figure 12) in the drill collar string and space stabilizers above and below the mill. Reaming with this hookup at fast rotary speeds usually will eliminate all slivers so packers and other frangible tools may be run through the milled section.—**The End**

About the Author



Jack Chadderdon is president of A-Z International Tool Company. He received his engineering training at Oklahoma State University and joined the engineering department of Houston Oil Field Material Company in 1942. On leaving their employment in 1953, he was Assistant General Superintendent in charge of engineering, research and development. He joined Servco as Vice President of Engineering and left them in 1958 to form A-Z International Tool Company. He has done considerable development work on fishing, directional and milling tools and holds several patents in this field.

North Dakota has rapid Mesozoic facies changes

Jurassic-Cretaceous boundary now thought to be gradational, not marked by unconformity; prospective stratigraphic traps indicated

By Dan E. Hansen, Geologist
North Dakota Geological
Survey, Grand Forks

THE RE-INTERPRETATION of the Upper Jurassic-Lower Cretaceous stratigraphy in the North Dakota portion of the Williston Basin suggests the possibilities of oil production in a section previously of little economic interest.

The boundary between the lithologic units of the Upper Jurassic-Lower Cretaceous interval in the North Dakota portion of the Williston Basin and adjacent areas heretofore has generally been interpreted to be at a major unconformity. This interpretation as applied in the subsurface of North Dakota is herewith substantially refuted. Instead, the Jurassic-Cretaceous contact is postulated to be gradational. The concept of a gradational contact originated during the study of the stratigraphic positions and lithologies of the units of a limited stratigraphic section immediate to the boundary.

Prior interpretation. Previously the author used the fine-to very coarse-grained quartzose sandstones (assigned to a Lower Cretaceous age and thought to indicate a transgressing Cretaceous sea) as the criteria to identify the postulated unconformity between the Jurassic and Cretaceous.[2] The boundary was then placed at a change in lithology from the greenish gray shales and fine-grained sandstones of the Jurassic to the fine-to very coarse-grained quartzose sandstones of the basal Lower Cretaceous. The very basal Cretaceous sandstone was then correlated as the Lakota sandstone equivalent, except in northeastern North Dakota where it was correlated as the Fall River equivalent.

Placing the boundary as just described resulted, however, in relatively abrupt changes in its stratigraphic position in northeastern North Dakota. These changes were first interpreted to be an indication of pre-Cretaceous erosion upon the Jurassic surface. After further study, it was decided that the Jurassic-Cretaceous boundary was not necessarily below a quartzose sandstone in northeast North Dakota, but could underlie a mostly non-marine section that would be interpreted as the lateral equivalents of the Lakota sandstone and, in part, the Fall River sandstone. Non-marine sediments were deposited in northeastern North Dakota—possibly the entire extreme east part—while the very Lower Cretaceous sands (probably mostly littoral) were deposited immediately to the southwest. The non-marine Cretaceous lithologies, as interpreted, are greenish gray, red-brown and gray shales, and calcareous, silty, fine-grained sandstones generally thought heretofore to be Jurassic. Stratigraphic position was the sole means of correlating the dissimilar lithologies, as paleontological evidence is rarely found in well cuttings from the Jurassic-Cretaceous section.

Present interpretation. The Jurassic-Cretaceous stratigraphic section chosen is bounded by probable time lines. The lower limit of the stratigraphic section studied is the boundary between the Rierdon and Swift formations of eastern Montana.[1] The lower limit is parallel to, but often times placed *20 to 30 feet below the top of the Rierdon "A."*[4] The upper limit is the "marker horizon" used as the boundary between the Upper and Lower Cretaceous.[2]

The arbitrary boundary and the experimental stage-like units are used to demonstrate the gradational nature of the contact.

The experimental stage-like units are:

1. *The XB unit* is equivalent to the Swift formation of eastern Montana

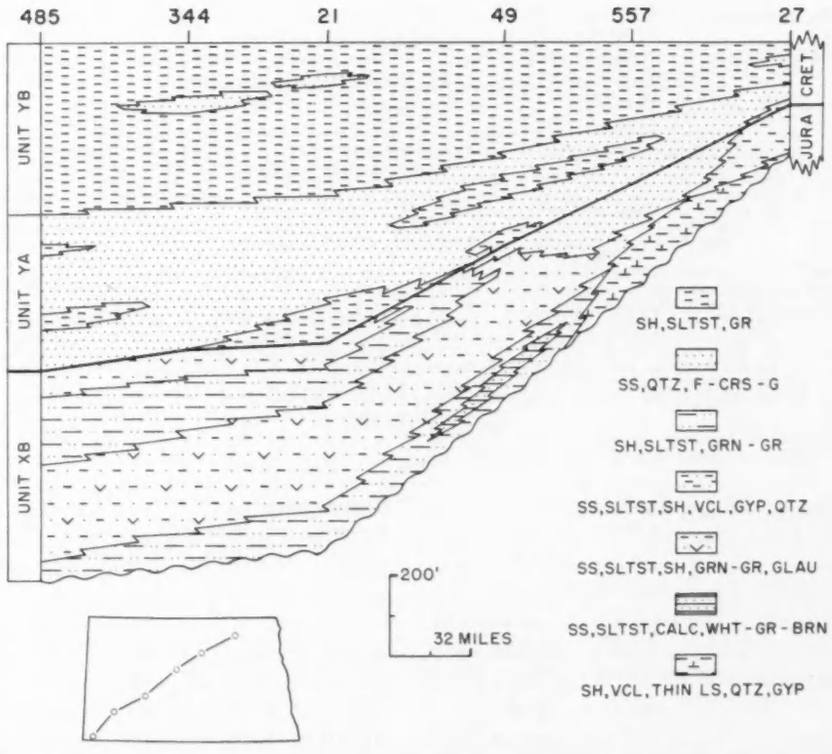


FIGURE 1—Cross-section from southwestern to northeastern North Dakota. Wells are (485) Hunt-Brook's State 1, Bowman County; (344) Plymouth's Fischer 1, Stark County; (21), Kelly-Plymouth's Leutz 1, Mercer County; (49), Stanolind's McLean County 1, McLean County; (557), Owen-Hyde's Schaan 1, Pierce County; (27), Union's Skjervheim 1, Cavalier County. Extensive facies changes, and arbitrary placement of Jurassic-Cretaceous boundary are shown.

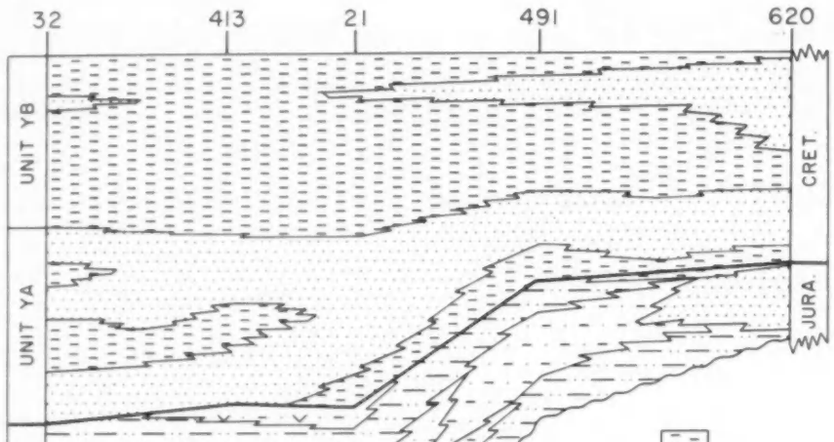


FIGURE 2—Cross-section from northwestern to southeastern North Dakota. Wells are (32) Amerada's Bakken 1, Williams County; (413) Carter's Lockwood 1, Dunn County; (21) Kelly-Plymouth's Leutz 1, Mercer County; (491) National Bulk Carriers' Miller 1, Morton County; (620) Calvert's Nitschke 1, McIntosh County.

TABLE 1—XB Unit

The stage-like arbitrary time rock XB unit of Jurassic age varies in lithology. This variance of lithology is described in the following table:

XB Unit	GEOGRAPHIC AREAS OF NORTH DAKOTA		
	Western	**North-central**	**Northeastern**
	A basal marine, greenish gray, gray shale unit; a middle marine, glauconitic, fine-grained quartzose sandstone and greenish gray, gray shale unit; and an upper marine, greenish gray, gray silty shale unit that, in many of the wells studied, is overlain by a marine, glauconitic, fine-grained quartzose sandstone unit. More arenaceous in southwestern North Dakota and gradually changes to the characteristics of the marine Sundance formation of the northern Black Hills. Up to 560 feet thick.	A basal marine greenish gray, brown, gray shale and light gray, calcareous sandstone and siltstone unit; and an upper marine to non-marine fine-to very coarse-grained quartzose sandstone unit. Up to 350 feet thick.	Consists for the most part of non-marine gray, greenish gray and vari-colored shales; light gray silstones; thin limestones; very fine-grained, calcareous sandstones; and traces of coarse quartz grains and gypsum. Up to 200 feet thick.
		South-central	**Southeastern**
		A basal marine greenish gray, gray and brown silty shale unit; a middle marine brownish gray to light gray sandstone and siltstone unit; and an overlying marine, light gray and greenish gray, silty shale unit. Up to 400 feet thick.	Consists of marine to non-marine fine- to very coarse-grained quartzose sandstone and gray, red-brown shales. Up to 200 feet thick.

and to the Sundance formation of the northern Black Hills.[3]

2. *The YA unit* consists of equivalents of the Jurassic Morrison formation[4] and the equivalents of the Cretaceous Lakota, Fuson and Fall River formations of the northern Black Hills.[2]

3. *The YB unit* is composed of equivalents of the Cretaceous Skull Creek, Newcastle and Mowrey formations of the northern Black Hills.[2]

The arbitrary Jurassic-Cretaceous boundary is the upper limit of the XB unit.

Stratigraphy. The time rock XB unit of Jurassic age varies in lithology. (See Table 1 and Figures 1 and 2.)

The pre-XB unit paleogeological map (Figure 3) illustrates the areal extent of the Jurassic Rierdon. The XB unit overlaps onto the Rierdon and both have a similar areal extent. The paleolithologic map of the middle of the XB unit (Figure 4) is an arbitrary horizontal slice to show the variance from a marine, fine-grained sandstone (glauconitic for the most part) in western and south-central North Dakota to a marine and non-marine fine-to coarse-grained quartzose sandstone in north-central and southeastern North Dakota. This in turn, varies to non-marine shales, siltstones and sandstones in the northeast.

The paleolithologic map of the top of the XB unit (Figure 5) illustrates a variance from a marine, glauconitic, fine-grained sandstone in the west to a marine green and gray shale unit that extends from the extreme northwestern to the south-central portion of the state. East of the marine sediments, one small area of quartzose sandstone, marine to non-marine, appears in central North Dakota and occurs because of the westward regression of the marine units. East of the quartzose sandstone and marine sediments, gray, silty shales (mostly non-marine) are shown. In northeastern North Dakota non-marine sediments are shown.

The Rierdon-XB unit contact is gradational in the northwest and the boundary is placed at a prominent point on electric and/or gamma ray logs. In the remainder of the state, the Rierdon-XB unit boundary lies at an unconformity. The unconformable contact of the XB unit and the underlying Rierdon formation in southeastern North Dakota is below a unit in which lithology varies from a calcareous siltstone and sandstone to an arenaceous limestone. Where the Rierdon is absent in southeastern North Dakota, the unconformity is below reddish shale overlying the Jurassic Piper limestone or Paleozoic limestones where the Middle Jurassic is absent. In southwestern North Dakota the boundary (indicated to be at an unconformity) is either below a thin calcareous siltstone and sandstone or an extremely thin arenaceous limestone. In northeastern North Dakota, the unconformable contact is below a unit of varicolored shales, thin limestones, and siltstones.

The Rierdon-XB unit boundary is thought to be a time line, because it is delimited by an unconformity of very low angularity in the east and south and an equivalent "marker horizon" in northwestern North Dakota.

YA Unit. The Cretaceous YA unit, overlying the Jurassic XB unit, reaches a thickness of 460 feet in western

North Dakota. (See Table 2 for a description of the YA facies.)

The lower boundary of the YA unit is the arbitrary Jurissic-Cretaceous boundary. In western North Dakota, the boundary is placed arbitrarily below a quartzose sandstone of the YA unit and above the glauconitic, fine-grained sandstone of the XB unit, or, where the glauconitic sandstone does not occur, above the greenish gray, silty shale of the XB unit. The boundary could be placed higher in the section; or it could be placed within or at the top of the very basal quartzose sandstone, identified at times as a lithologic unit in northwestern North Dakota and as an equivalent unit containing Jurassic Morrison (?) in the southwest. It then would be at a stratigraphic position more in accord with the position of the boundary further east. The author, however, could not solve the problem satisfactorily and placed the lower boundary of the YA unit below the series of fine-to-coarse-grained quartzose sandstones. The lower YA unit boundary in southeastern North Dakota is placed arbitrarily below or within a gray, silty shale that separates two quartzose sandstones of similar texture.

In north-central North Dakota the boundary is placed at the bottom of a thin gray shale within the lower part of a series of fine-to coarse-grained quartzose sandstones. If the gray shale is not present, it is placed at the first convenient "break" within the quartzose sandstones that corresponds to the stratigraphic position of the gray shale. In the northeast, placing the arbitrary lower YA unit boundary is difficult. The lower YA boundary is placed by a combination of stratigraphic position and the last occurrence of coarse quartz grains in the gray, brown and green-gray shales and gray siltstones immediately below the thin quartzose sandstone of the YA unit.

In summary, the lower YA unit boundary, the Jurassic-Cretaceous boundary, is placed by stratigraphic position. The strata immediately above and below the boundary are very similar in texture and composition in eastern North Dakota. The similarities of the strata (marine to non-marine) of the XB and YA units as interpreted in the east and the gradational nature of the marine to non-marine strata of the XB unit are used to indicate that the Jurassic-Cretaceous contact is gradational and not at an unconformity.

YB Unit. The YB unit, overlying the YA unit, reaches a thickness of 470 feet in western North Dakota. The lithology of the units is relatively simple and is illustrative of sandstone and shale facies relationships that were the result of transgressive and regressive movements of the Cretaceous sea. The subdivisions of the YB unit in ascending order are: a marine medium gray to dark gray shale termed the Skull Creek shale; a non-marine to marine, discontinuous, fine-to very coarse-grained sandstone termed the Newcastle sandstone; and a marine, dark gray shale termed the Mowry shale.

The lower boundary of the YB unit is placed with some difficulty because of the slight time transgressive nature of the contact of the underlying uppermost sandstone of the YA unit and the overlying Skull Creek shale of the YB unit. The lower boundary of the YB unit in eastern North Dakota is for the most part arbitarily placed at the top of the uppermost sandstone of the YA unit, a sandstone previously

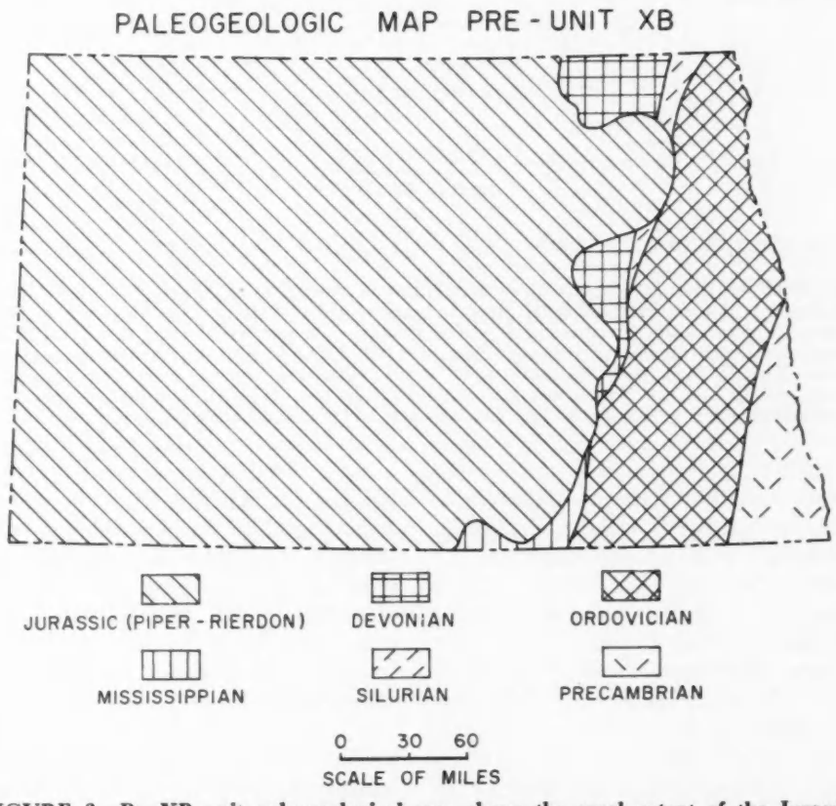


FIGURE 3—Pre-XB unit paleogeological map shows the areal extent of the Jurassic Rierdon. Piper-Rierdon beds are present over the entire state of North Dakota with the exception of the extreme east portion. There it unconformably overlaps existing Paleozoic formations.

TABLE 2—YA Unit

The Cretaceous YA unit, overlying the Jurassic XB unit, is described as to lithology in the following table:

YA Unit	GEOGRAPHIC AREAS OF NORTH DAKOTA		
	Northwestern	**Southwestern**	**Northeastern**
	In some of the wells studied the unit can be separated into three lesser units consisting of a very basal fine- to coarse-grained quartzose sandstone containing gray shales; a gray shale; and an overlying fine- to medium-grained quartzose sandstone, gray shale, and siltstone unit. For the most part the shales thicken and thin rapidly to make separation into units difficult. Up to 460 feet thick.	In some of the wells studied the unit is separable into three lesser units of quartzose sandstone and gray shale, but the equivalent of the very basal fine- to coarse-grained quartzose sandstone of northwestern North Dakota also consists, at times, of quartzose sandstone, varicolored shale, and siltstone that could be equivalent to the Jurassic Morrison. This relationship needs more study. Up to 460 feet thick.	Consists of a silty, medium-grained quartzose sandstone that grades, in a northeast direction, into a unit of varicolored shales and light gray siltstones overlain by a thin, primarily coarse-grained sandstone. Up to 125 feet thick.
	North-central	**South-central**	**Southeastern**
	Consists of a fine- to coarse-grained sandstone with interbedded gray shales. Up to 250 feet thick.	Consists of basal light gray silty shale and an overlying fine- to very coarse-grained quartzose sandstone. Up to 330 feet thick.	Consists of fine- to very coarse-grained quartzose sandstone with interbedded gray shales. Up to 250 feet thick.

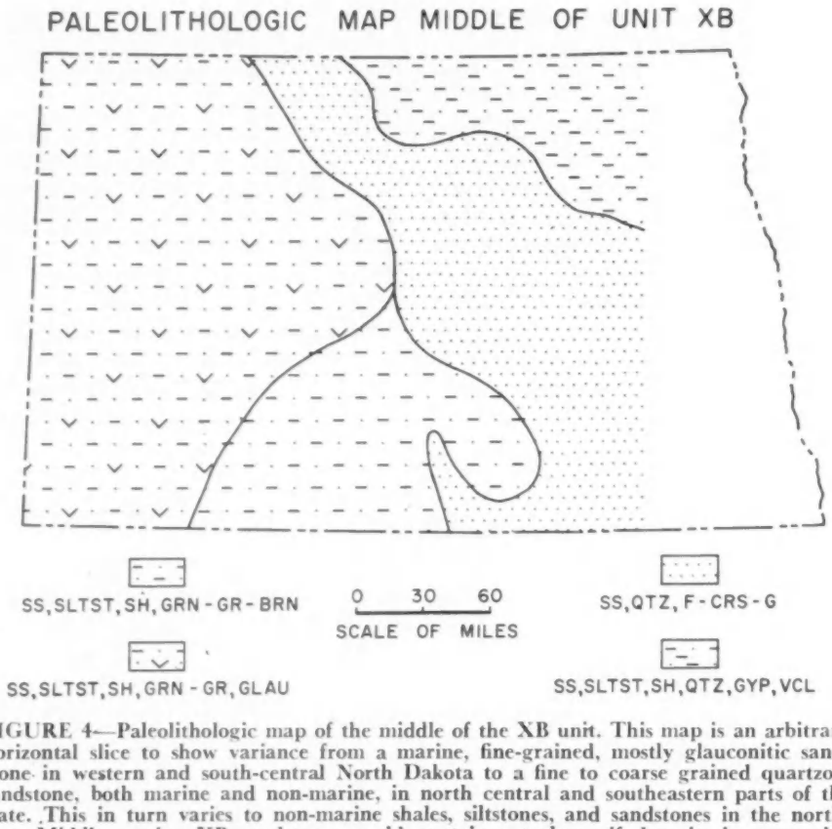


FIGURE 4—Paleolithologic map of the middle of the XB unit. This map is an arbitrary horizontal slice to show variance from a marine, fine-grained, mostly glauconitic sandstone in western and south-central North Dakota to a fine to coarse grained quartzose sandstone, both marine and non-marine, in north central and southeastern parts of the state. This in turn varies to non-marine shales, siltstones, and sandstones in the northeast. Middle marine XB sandstones could contain petroleum if deposits in permeable sandstones pinching out updip into impermeable strata could be found.

termed the Fall River by the author.[2] In western North Dakota a "marker horizon," a prominent point on the gamma ray log and coincident with the top of the uppermost sandstone of the YA unit, is used to place the lower boundary of the YB unit. However, the writer is unsure of the continuation of the "marker horizon" throughout the state. Furthermore, since the interface of the Skull Creek shale and the uppermost sandstone of the YA unit apparently transgresses time at such a low angle the top of the sandstone is used as the lower boundary of the YB unit. The upper boundary of the YB unit appears easy to identify as it is a prominent point on the gamma ray and electric logs. This prominent point, a "marker horizon," is below a thin, bentonitic, silty and arenaceous shale unit and is used to indicate the boundary between the Upper and Lower Cretaceous.

Tectonism and sedimentation. The regional tectonism that controlled the deposition of the Jurassic sediments in North Dakota caused an unconformity to be developed during the change from the Jurassic Rierdon to the XB unit depositional environments. However, in northwestern North Dakota the Jurassic Rierdon-XB unit contact is conformable and the change was gradual. Following the development of the unconformity between the Rierdon and the XB unit, uplift tendencies ceased for a time and subsidence was dominant during the deposition of the lower marine shale of the XB unit. After deposition of the lower shale of the XB unit regional uplift was the dominant tectonic process and areas to the southwest, south and east were probably the most effective as source areas for the sediments deposited. During this uplift the middle marine sandstones and shales of the XB unit were deposited in western North Dakota. Marine and non-marine strata (quartzose sandstone and light gray shales for the most part) were deposited in eastern North Dakota during deposition to the west of the middle marine sediments of the XB unit. A temporary tectonic balance was sustained and the non-marine to marine sediments continued to be deposited in eastern North Dakota while the upper marine shale of the XB unit was deposited in western North Dakota. However, regional uplift became effective again—probably an uplift southwest of the state was the most effective—and the uppermost marine, glauconitic sandstone of the XB unit was deposited in western North Dakota. The uppermost marine glauconitic sandstone is gradational into the overlying marine to non-marine strata of the Cretaceous YA unit in western North Dakota. During this time marine to non-marine sediments continued to be deposited in eastern North Dakota. Following the deposition of the uppermost marine, glauconitic sandstone the environments characteristics of the marine Jurassic disappeared in the state.

The facies changes characteristic of the Lower Cretaceous were widespread in North Dakota following the last deposition of the Jurassic marine sediments in western North Dakota. The marine to non-marine environments had spread over the state mostly from the eastern half. In addition, uplift of source areas to the southwest and south continued to contribute sediments to the same area. A relaxation of the uplift tendencies followed and the marine portion of the uppermost sandstone of the YA unit and the overlying marine Skull Creek shale were deposited in North Dakota. However, one more regional uplift occurred that resulted in the deposition of the marine to non-marine, quartzose, and discontinuous equivalent to the Newcastle sandstone. The effect of the uplift was greatest in southeastern North Dakota where thicker deltaic (?) sediments of the Newcastle were deposited. This is the last evidence of extensive uplift in the state until the close of the Cretaceous.

The "marker horizons" (top of unit YB and bottom of unit XB) are useful as datum points for subsurface structure maps because of their near parallelism to time lines. The "marker horizons" and the arbitrary Jurassic-Cretaceous boundary are probably the precise limits of the stratigraphic intervals that should be used when applying mathematical methods of stratigraphic analysis, such as lithofacies and sand-shale ratio maps.

The accumulation of petroleum in the interval studied of the North Dakota portion of the Williston Basin appears to depend more on the successful development of stratigraphic traps (localized development of porosity and permeability) rather than those of structure. This is emphasized while discussing various units.

The lower shale of XB unit appears to contain no possibilities of petroleum accumulation. The middle ma-

rine sandstones and shales of the XB unit could contain petroleum if accumulations in permeable and porous sandstones pinching out updip into impermeable sandstones and shales could be found. For example, offshore bars and/or channel sandstones could have been developed in central and southern North Dakota where the middle XB unit marine sandstones and shales grade into non-marine sandstones and shales (see Figure 4). The uppermost marine sandstone of the XB unit (see Figure 5) could also be locally developed in porosity and permeability to form stratigraphic traps for petroleum accumulation. Examples in an equivalent interval to the XB unit are found in the Saskatchewan portion of the Williston Basin in the Cantuar, Fosterton, Gull Lake, Success, North Premier, Battrum, Verlo and Wapella fields.

The very basal sandstones (considered Lower Cretaceous in age for this discussion) of the YA unit are very discontinuous and may be marine, at least in part, in the deeper parts of the Williston Basin of western North Dakota. Hence, there are possibilities of stratigraphic traps in these sandstones. The nearest production in sandstones equivalent to those of the basal part of the YA unit is in the Cat Creek field of central Montana, a field not in the Williston Basin. The uppermost sandstone of the YA unit is mostly marine, but because the sandstone is continuous throughout the greater part of North Dakota there appears to be little likelihood of stratigraphic trap accumulations except in the upper interval of western North Dakota, and that too appears very remote.

The YB unit contains equivalents of the Newcastle sandstone, a prolific producer on the west flank of the Black Hills in the Powder River Basin of Wyoming. These equivalents are discontinuous, marine to non-marine, channel and deltaic (?) sandstones that could well be potential petroleum reservoirs in southwestern North Dakota where they thicken and thin rapidly in this area and stratigraphic traps in this unit are quite probable. There is, of course, no petroleum production from this interval and preceding intervals discussed in the Williston Basin portion of North Dakota. So far this sandstone and underlying Jurassic-Cretaceous sandstones are known only as producers of artesian water in North Dakota.

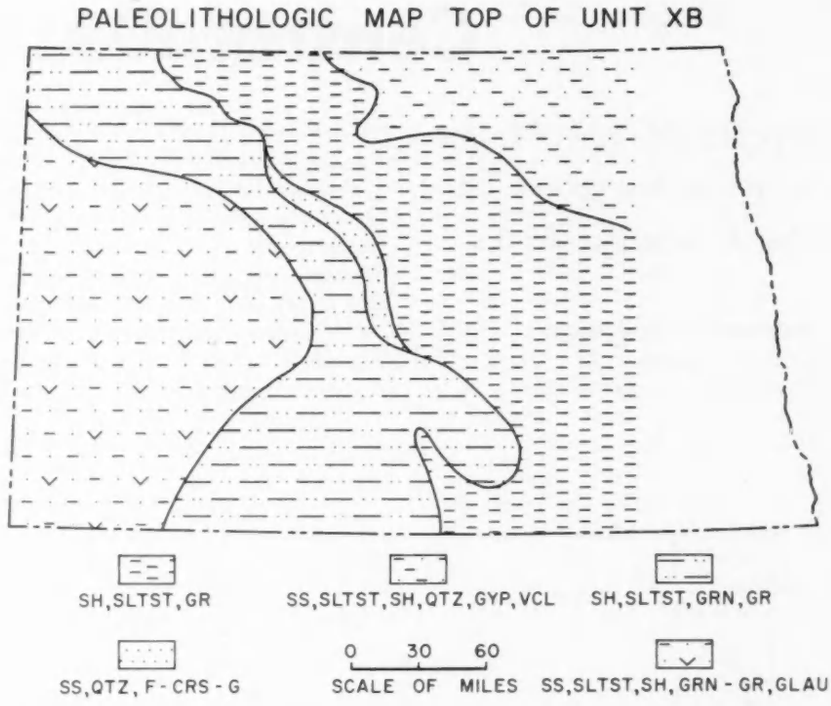


FIGURE 5—Paleolithologic map of top of XB Unit. Uppermost marine sandstone of XB unit may be locally prospective for oil in stratigraphic traps.

In summary, the regional tectonism, epeirogenic movement that controlled the deposition of the subject Jurassic and Cretaceous sediments primarily caused a "silting in" of the marine Jurassic Basin and the later development of a marine basin of a different environment during the Lower Cretaceous. The epeirogenic movement that controlled the deposition of the Jurassic sediments can be described as a gradual uplift with intermittent subsidence. Conversely, the epeirogenic movement that controlled the deposition of the Cretaceous sediments can be described as a gradual subsidence with intermittent uplift.

The lithologies and environments discussed are time transgressive. The Jurassic lithologies and environments mostly appear to be time transgressive in a western direction in North Dakota. The overlying gross Cretaceous lithologies appear to be primarily time transgressive in an eastern direction. The Jurassic-Cretaceous boundary is then wrapped in a history of regional tectonics. The boundary appears to be primarily gradational in North Dakota.

(The writer thanks the State Geologist, North Dakota Geological Survey for permission to publish this article. The article is a modified and condensed version of a paper presented at the Second International Williston Basin Symposium, Regina, Saskatchewan, 1958.)

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About the Author

Dan E. Hansen studied at the University of North Dakota where he received a B.S. in geology degree in 1950, and a M.S. in geology degree in 1955. He started working for the North Dakota Geological Survey in 1954. He is a member of the American Association of Petroleum Geologists, North Dakota Geological Society, North Dakota Academy of Science, Society of Sigma Xi, and Sigma Gamma Epsilon.

Central Kentucky activity

Independents and Majors enliven shallow plays bordering Cincinnati Arch

By Harrison T. Brundage
Exploration Editor
WORLD OIL

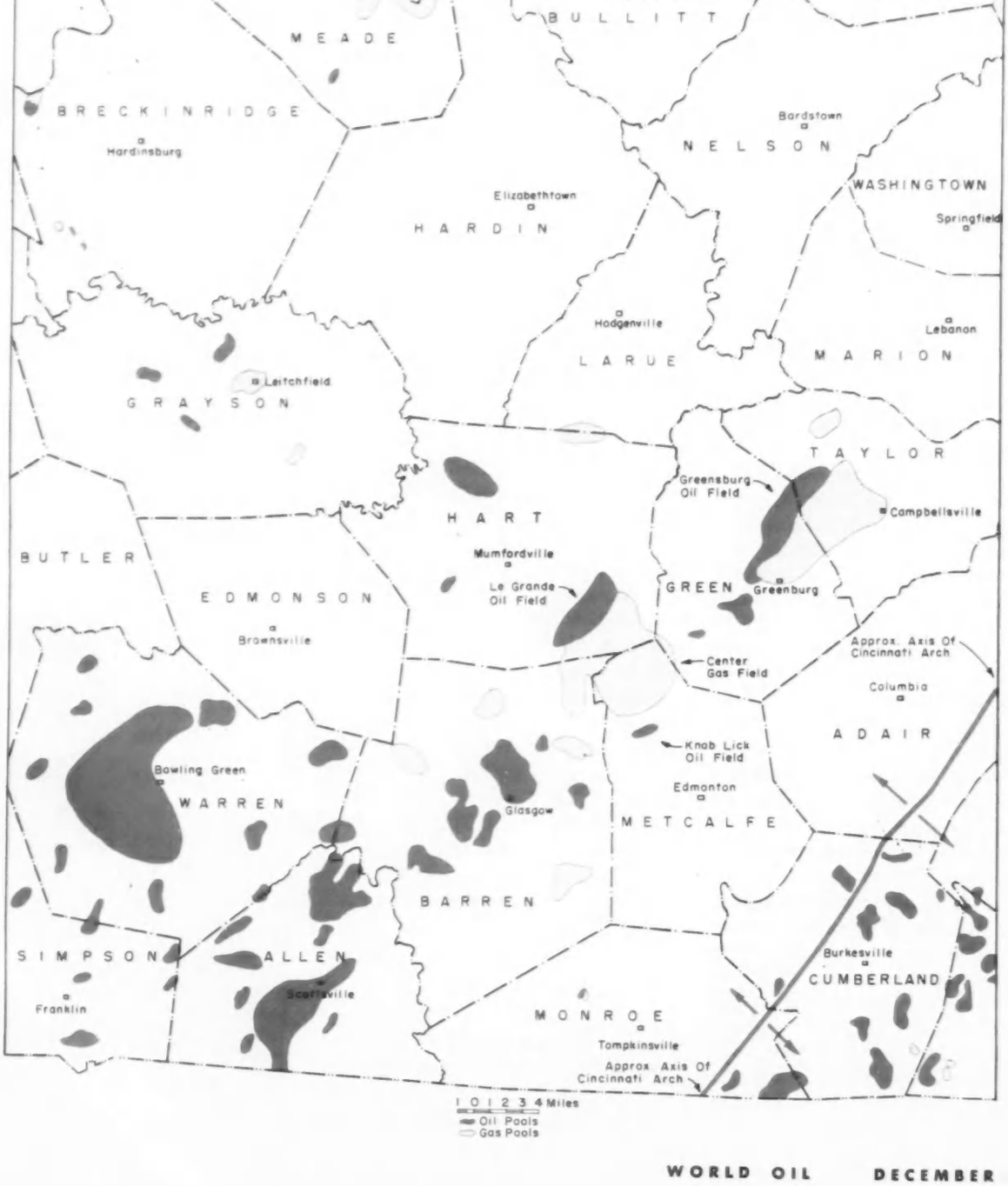
MANY NEW OPERATORS from all over the United States are flocking to central Kentucky following the Greensburg field oil boom.

Among the more encouraging discoveries made in central Kentucky since Greensburg are the following:

• Completion of a Fort Payne reef discovery for 300 barrels of oil daily on pump near Edmonton, Kentucky, in Metcalfe County, from the interval 212-232 feet, in March, 1959. This well pumped 23,107 barrels of crude in 90 days. Up to 100 feet of crinoidal reef facies has been reported in the Fort Payne in eastern Metcalfe County. The Fort Payne is of middle Mississippian age.

• The Knob Lick oil field, where about 43 feet of Mississippian pay was

CENTRAL KENTUCKY



to reach record heights

found earlier this year, is being extended. Knob Lick is located in Metcalfe County also. There are three pay zones: the "Beaver" which here directly overlies the Devonian black shales; the "Corniferous", a driller's term for an erratic carbonate section lying directly below the shales, and the "Blue sand," a porosity zone in the Laurel dolomite (Silurian) which is also the main pay at Greensburg.

• Other important discoveries west of the Cincinnati Arch were reported in Grayson, Hardin, Simpson, and Edmonson counties, Kentucky.

Activity is also reported vigorous in Monroe, Cumberland, and Clinton counties, approximately at the top of the Cincinnati Arch and directly east of it. Five Knox dolomite tests were reported under way in Clinton County in October. Considerable activity is also reported in Wayne County, adjoining on the east. Primary targets are the "Beaver", and the several porosity zones of the Trenton (Ordovician), the Sunnybrook and Granville horizons.

The most intensive current leasing activity in central Kentucky is concentrated in Barren, Allen, Warren, Monroe, Metcalfe, Hart, Green, Taylor, Grayson, Larue, Marion, Hardin, Meade and Breckinridge. These counties overlie Silurian rocks west of the Cincinnati Arch. However, leasing is also active east of the Arch and in eastern Kentucky. Hunt Oil Company holds between 300,000 and 500,000 acres in central and eastern Kentucky and adjoining counties in Tennessee. Hunt has invited virtually all operators in the area to drill offsets to its acreage, offering a minimum of $1.50 per foot dry hole money for wells 750 feet or deeper, subject to their running logs and observance of other proper exploratory drilling procedures.

The Laurel is dolomitic in Summer County, Tennessee, but changes to a dense limestone farther south. Still farther south, in Alabama, Silurian beds yield hematite and limestone to serve as ore and flux for Birmingham's steel mills.

ACTIVITY IS PICKING UP in Tennessee, with heavy current leasing activity in Macon, Sumner, Robertson, Dickson and Montgomery counties, along the northwest flank of the Nashville dome. Gulf Oil Corporation took a large acreage spread in Sumner County. Hunt Oil Company was drilling in Clay County at the same time. Scattered lease plays were reported on the Nashville Dome and as far south as Alabama.

As of November 1, there were 32 rigs active in Tennessee. Normally about 12 rigs are running at this time of year.

In southern Ohio and Indiana, adjoining Boone County, Kentucky, activity is being stimulated on the Cincinnati Arch. Continental Oil Company is engaged in a drilling program in this tri-state area.

There is no obligation to file drilling permits in Kentucky outside of coal areas, hence drilling statistics are difficult to acquire. Many shallow tests are plugged with no record being made. However, a recent aerial reconnaissance of central Kentucky gave an estimate of 300 active drilling rigs, including 50 in the Greensburg Field and 250 on other tests. Hence, many new pools are expected to be brought in during the near future.

GREENSBURG FIELD DEVELOPMENT

Statistical details of crude oil production in Green and Taylor counties in 1958 and 1959 are found in Table 1. Only a very small yield of crude was being taken from Green County in early 1958, and none from Taylor. Greensburg field output increased to almost 18,000 barrels daily in December 1958; to a peak of 45,500 barrels a day in May 1959, decreasing thereafter to 41,000 in June, 33,500 in July, and 28,200 in August. As of November 4, Ashland Oil and Refining Company's pipe line runs,

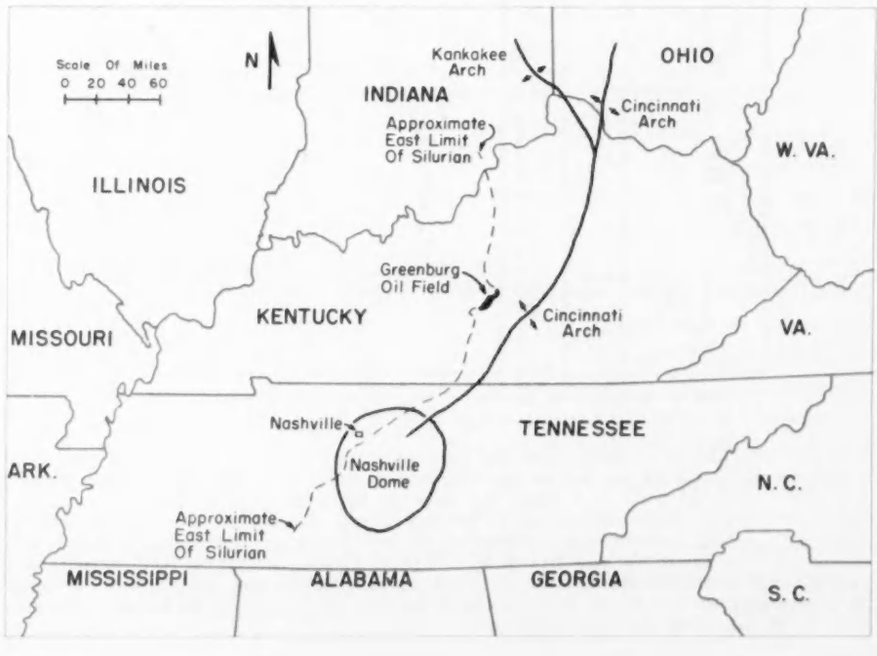


FIGURE 1—Truncation of Silurian and basal Devonian beds (left) on the west flank of the Cincinnati Arch by draped-over Devonian shales is an extremely important factor to oil and gas accumulation. Interest in Knox dolomite possibilities is growing, especially along the top of the Arch in Cumberland (Ky.) and adjacent Kentucky and Tennessee counties. Interest in Mississippian and older Paleozoic possibilities east of the Arch is growing, particularly in Clinton County (east of Cumberland). The peculiar, variable configurations of these fields shows their primarily stratigraphic nature. Many are porosity zone reservoirs in limestones and dolomites.

FIGURE 2—This sketch map (right) shows the general configuration of important regional structural and stratigraphic features in central Kentucky and Tennessee. Heavy drilling play continues in central Kentucky counties west of the Cincinnati Arch and east of the limit of Silurian beds. However, vigorous leasing and drilling for Mississippian, Devonian, and Ordovician prospects on both sides and atop the Arch is underway. The play is spilling over into Tennessee, Ohio, and Indiana.

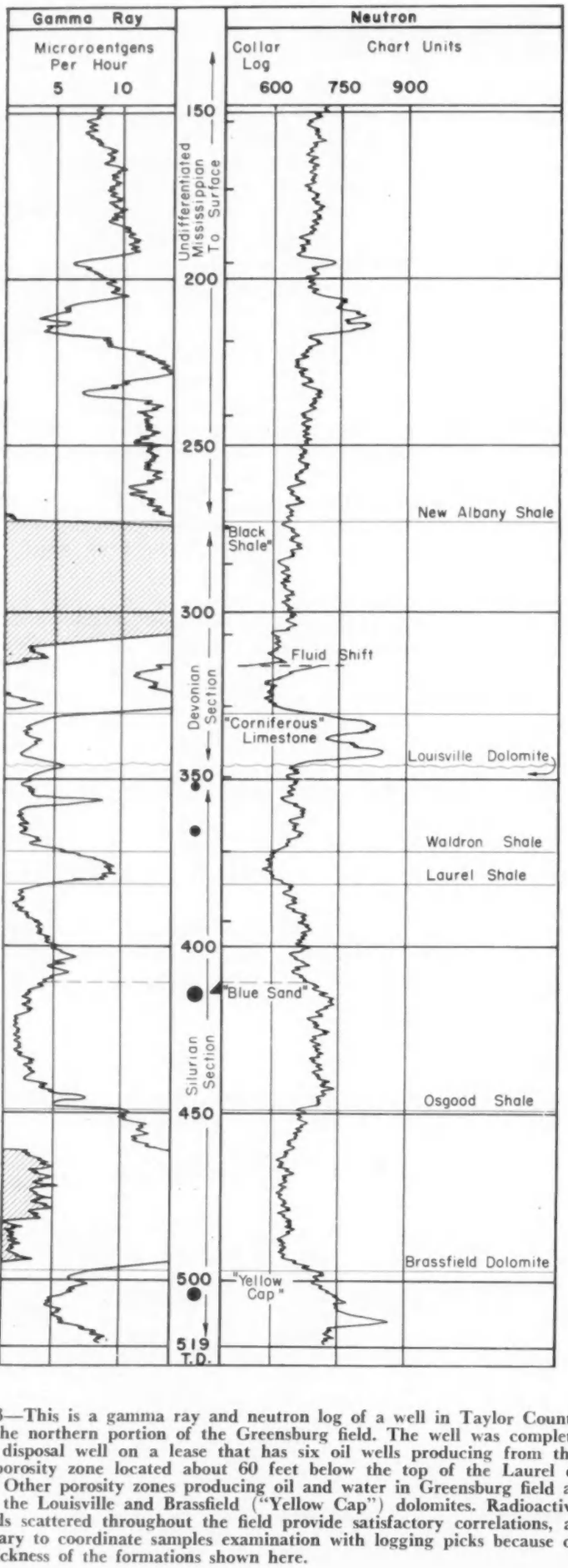


FIGURE 3—This is a gamma ray and neutron log of a well in Taylor County, Kentucky, in the northern portion of the Greensburg field. The well was completed as a salt water disposal well on a lease that has six oil wells producing from the "Blue Sand", a porosity zone located about 60 feet below the top of the Laurel dolomite (Silurian). Other porosity zones producing oil and water in Greensburg field are indicated, i.e., the Louisville and Brassfield ("Yellow Cap") dolomites. Radioactivity logs run in wells scattered throughout the field provide satisfactory correlations, although it is necessary to coordinate samples examination with logging picks because of variations in thickness of the formations shown here.

which account for most of the field's output, were running at 24,000 barrels daily, representing the bulk of the field's yield.

It is hoped that the reservoirs will show evidence of a partially effective water drive, in addition to the dissolved gas drive, and reservoir pressure due to the weight of the overburden.

More than 200 rigs were probably active in Greensburg Field during the height of the boom in mid-1959. This has been decreased to about 50, but activity is expected to remain steady or to increase slightly as drilling commitments mature. Activity has been decreasing in Green County but increasing in the newer Taylor County portion of the field.

Virtually all of the field drilling has been with cable tools. There were never more than about six rotaries active. The rigs have almost all been truck- or trailer-mounted machines.

As of September 1959, Ashland Oil and Refining Company had purchased oil run from 2,154 wells; hence, there have been at least that many completions. Including non-producers, at least 2,300 wells must have been completed in the field.

There are probably 200 to 300 individual operators in Green County, representing thousands of minority interests.

Probably about 15,000 acres has been proven. A considerable portion of the field remains to be drilled up. Operators have generally concentrated on drilling along their lease lines to protect against drainage. Hence, many inside locations have been neglected in the race to drill offsets.

One of the brighter aspects for future production is the Louisville limestone (see Figure 3) which is apparently productive in Green County and shows good oil saturation in the Taylor County portion of the field. If some new completions can be successfully achieved in the Louisville, the field area may be extended significantly westward in Taylor County.

Recoverable primary crude oil reserves are placed at about 22 million barrels, of which about 11 million have already been produced. Recoveries are expected to range from 1,000 to 2,500 barrels per acre, with the

average expected at about 1,500 barrels or a little higher.

As shown in Figure 3, the section drilled consists almost entirely of Mississippian and Silurian carbonates, with some shale layers. Porosity zones in the Louisville dolomite at about 375 feet, in the Laurel dolomite "Blue Sand" horizon at about 420 feet, and the Brassfield dolomite ("Yellow Cap") yield oil, generally with large proportions of salt water and a small amount of gas. The Laurel porosity zone is the main pay; permeability generally runs about 1 to 2 darcys, and porosity about 11 to 12 percent. This pay zone varies in thickness from 10 to 30 feet. The Laurel is fossiliferous and is believed by some geologists to represent a reef facies.

Individual wells initially produce from a few barrels to 500 barrels daily. The average is probably about 30 barrels per day per well. All wells are on pump. Water pumps have been used effectively to move large amounts of fluid.

Since very few wells are water-free, and some that are do not produce much oil, most Greensburg field operators believe that oil production is dependent upon water to move it from the reservoir. Hence, there is very little effort to effect water-free completions.

Bottom hole pressures are negligible and do not exceed 50 pounds except in unusual cases where a gas pocket occurs. This can be a hazard in drilling. The shallow Mississippian rocks are irregularly dissolved in occasional caverns. Farther west in Kentucky, Mammoth Cave has been dissolved out of Mississippian carbonates.

The crude is 42-degree API gravity, paraffin base, and is sweet. Ashland pays $2.60 per barrel in most of the Greensburg field area, with a trucking charge where necessary, but not less than $2.50 in any point in the field.

Since no spacing pattern has been followed, much of the field is overdrilled, some of it under-drilled. Owing to uncontrolled offsets and the frequent practice of putting wells (particularly offsets) on vacuum, parts of the field have been depleted at a too rapid rate.

A satisfactory field drilling practice has been the following program:

1. Drill (with cable tools) 10-inch surface hole, 10 to 40 feet deep to penetrate weathered zone to hard bedrock, and set 8⅝-inch surface string.

2. Drill 8-inch hole to the top of the "Blue sand" and set casing. Seven-inch may be run, but 5½-inch is preferable since cement can be circulated. About 35 sacks of cement are used.

3. Drill thru the "Blue", the Osgood, and top the "Yellow Cap" (Figure 3). Bail out the hole and dump acid. Acid jobs vary from 2,000 to 10,000 gallons of HCl with emulsion breaker.

Outside the Greensburg field, another operator recommended the following program:

1. Drill thru the pay zone.

2. Backfill the hole with pea gravel to the top of the pay.

3. Set a 3-5 foot plug of temporary cement atop the pea gravel to keep cement off the pay formation.

4. Set 5½-inch or 4½-inch oil string, and cement with 10 to 40 sacks, depending on how cavernous the formations near the casing seat are.

5. Drill out the temporary cement plug.

6. Acidize, with packer in the casing (or shoot or fracture as required).

7. Clean out acid water and pea gravel. If cable tools are used, the well is bailed out; or if air rotary is used, the pea gravel and fluid may be blown out.

Average rigging-up time in Greensburg field with the small drilling machines is about half a day. Average completion time from spud-in to production in tanks does not exceed 10 days under proper operation.

Wells drilled and logged properly generally cost about $8,000 completed to the tanks. If it is desired to run pipe through the pay zones and perforate, such wells can be more expensive. However, there is little need for water-free completions, and care must be taken to avoid placing permanent cement on pay formations. Hence, "barefoot" completions are preferred.

Prevailing drilling rates are about $4 per foot. Hourly rates range from $6 to $10 depending on the equipment being used.

Production for sale. Many Greensburg field leases are changing hands, for one or more of the following reasons:

1. The lease may be depleted, perhaps because of over-drilling and/or too rapid production;

2. The operator may wish to sell out for capital gains purposes after six months;

3. The wells may be improperly completed;

4. Particularly in the Taylor County portion, the "Blue Sand" datum appears to represent a slightly hummocky surface; the productivity of many leases is strongly affected by whether the pay comes in high or low. A few feet may make the difference between profit and loss.

5. The lease agreement may be too heavily burdened. Landowners and promoters have become continually more demanding as the Greensburg play has developed.

Some profitable production purchase deals may exist in cases in which the operator simply wants to sell out and return home, or to raise capital for exploration outside of Greensburg field. Generally it is good practice to purchase via a cash down payment and agree to future production payments for the remainder, so that the purchaser is protected against depletion. —**The End**

TABLE 1—Crude Oil Production in Green and Taylor Counties, Kentucky*

	GREEN COUNTY				TAYLOR COUNTY	
	1958		1959		1959	
	Barrels	Barrels Daily	Barrels	Barrels Daily	Barrels	Barrels Daily
January	5,454	176	613,627	19,794	88	3
Febuary	5,674	203	586,707	20,954	414	15
March	8,009	258	799,257	25,782	7,534	24
April	8,450	282	1,158,804	38,627	19,777	659
May	18,216	588	1,386,904	44,739	34,704	1,119
June	21,054	702	1,143,464	38,115	91,493	3,050
July	30,270	976	939,331	30,301	105,015	3,388
August	63,107	2,036	733,321	23,656	148,723	4,798
September	162,244	5,408	[1]	.....	[1]	.....
October	308,860	9,963	[1]	.....	[1]	.....
November	468,529	15,618	[1]	.....	[1]	.....
December	556,181	17,941	[1]	.....	[1]	.....
Total	1,656,048	4,537	7,361,415[2]	30,294[2]	407,748[2]	1,678[2]

* Mostly from Greensburg Field after midyear 1958 when development got under way. Data courtesy of Edmund Nosow, Kentucky Geological Survey, Lexington.
[1] Data not available at of time of printing.
[2] First eight months of 1959.

Earnings better in 1959; further gains are promised

By L. J. Logan
Associate Editor, WORLD OIL

FOR THE THIRD quarter of this year, 46 oil companies reported combined net income of $683,837,000, an increase of 1.4 percent over the $674,408,000 they earned in the third quarter of 1958.

For the first nine months of 1959, the same 46 companies had a profit of $2,021,413,000. That was about $275 million or 15.7 percent more than earnings in the first nine months of 1958.

This year's third quarter failed to show as much gain over a year ago as did the first two quarters for several reasons. The most important was that the first and second quarters contrasted with the worst months of the 1958 recession, but the recent third quarter compared with a period in 1958 when recovery started and made considerable progress.

Furthermore, this year's third quarter was somewhat disappointing because oil industry prices remained unstable under the weight of surplus stocks of refined products. Crude production and refinery runs were rather strictly curtailed, and crude stocks were reduced. But previously accumulated surpluses of refined products remained on hand and adversely affected markets.

In the fourth quarter, as in the third, profits may be generally about the same as in the like period last year. Volumes of oils sold may be somewhat larger. But prices will average somewhat lower. And some industry costs, including labor and materials, have increased, although there have been some offsetting savings and cost reductions in economy moves.

If industry earnings in the fourth quarter are about the same this year as last year, then profits for the whole year of 1959 will show an increase of about 11 percent over 1958.

Oil industry earnings may be better in 1960 than in 1959 by at least 5 to 10 percent. Demand for petroleum is expected to increase about 4 percent. Crude prices appear fairly safe, and product prices promise to improve somewhat over 1959's depressed levels.

Third quarter earnings exceeded last year by more than 30 percent for Clark Oil & Refining, Union Oil & Gas of Louisiana, Richfield, Quaker State, Anderson-Prichard, Imperial, and International. Gains of 20 percent or more were experienced by Woodley, Sunray Mid-Continent, Continental, Louisiana Land, and Honolulu. Smaller increases were shown by Phillips, Standard of New Jersey, Texaco, Ohio Oil, Cities Service, and Standard of Kentucky. Profits versus deficits were reported by Tidewater, Colorado Oil & Gas, and Delhi-Taylor.

Third quarter profits were smaller than last year for 25 companies, including Gulf, Standard of California, Socony, Atlantic, Sun, Standard of Indiana, Sinclair, Pure, Standard of Ohio, Skelly, Shell, Signal, Union of California, Champlin, Plymouth, Texas Gulf Producing, Texas Pacific Coal & Oil. —**The End**

Net Earnings of Some Oil Companies in 3rd Quarter and First 9 Months, 1959 vs. 1958

(All "per share" data based on number of shares of common stock outstanding Sept. 30, 1959.)

	THIRD QUARTER					FIRST NINE MONTHS				
	$ Thousand		$ Per Share		%	$ Thousand		$ Per Share		%
COMPANY	1959	1958	1959	1958	Diff.	1959	1958	1959	1958	Diff.
Amerada Pet.	$5,902	$5,677	$0.93	$0.90	+ 4	$17,563	$15,527	$2.78	$2.46	+ 13
Anderson-Prich.	1,823	1,380	1.04	.77	+ 32	4,867	2,757	2.75	1.48	+ 77
Argo Oil	1,225	1,479	.63	.76	— 17	3,636	3,810	1.87	1.96	— 5
Ark. Fuel Oil	1,220	1,378	.32	.36	— 12	4,249	4,701	1.12	1.24	— 10
Atlantic Ref. Co.	7,575	11,513	.80	1.24	— 34	23,975	19,180	2.54	2.02	+ 25
Bishop Oil Co.	d1	53	...	.10	.....	d20	99	.....	.18	.....
Champlin O. & R.	1,840	2,150	.43	.51	— 14	6,144	5,044	1.43	1.17	+ 22
Cities Service Co.	8,397	7,694	.78	.72	+ 9	27,302	32,312	2.54	3.01	— 16
Clark O. & R. Co.	915	417	.60	.28	+119	1,921	639	1.28	.42	+ 20
Colon Oil Co.	289	1,107	.....	.....	— 74	677	2,521	.....	.....	— 73
Colorado O. & G.	731	d706	.19	d.28	.....	1,765	d111	.43	d.18	.....
Continental Oil	16,170	13,210	.77	.63	+ 22	45,330	33,863	2.15	1.60	+ 34
Delhi-Taylor Oil	1,267	d341	.24	d.06	.....	2,727	d1,056	.52	d.20	.....
Felmont Pet Corp.	481	561	.12	.15	— 14	1,795	1,503	.46	.39	+ 19
Gulf Oil Corp.	74,661	88,656	2.24	2.66	— 16	216,475	204,393	6.49	6.13	+ 6
Honolulu Oil	3,614	3,010	.96	.80	+ 20	10,057	8,595	2.68	2.29	+ 17
*Imperial Oil	14,346	10,174	.46	.32	+ 41	37,680	34,327	1.20	1.09	+ 10
*International Pet.	5,700	4,100	.39	.28	+ 39	15,800	13,100	1.08	.90	+ 21
La. Land & Explo.	4,968	4,114	.55	.46	+ 21	14,136	12,975	1.57	1.45	+ 9
Maracaibo Oil	55	80	.11	.16	— 31	193	219	.39	.45	— 12
Midwest Oil Corp.	1,493	1,656	.60	.66	— 10	4,964	5,003	1.98	1.99	— 1
Mission Corp.	1,444	1,359	.37	.34	+ 6	4,396	4,366	1.10	1.09	+ 1
Ohio Oil Co.	8,766	7,941	.63	.57	+ 10	27,323	23,028	1.95	1.64	+ 19
Phillips Pet. Co.	24,177	21,198	.70	.62	+ 14	77,386	57,609	2.25	1.68	+ 34
Plymouth Oil Co.	611	1,356	.24	.53	— 55	2,796	2,876	1.09	1.12	— 3
Pure Oil Co.	6,094	6,741	.70	.77	— 10	19,242	17,416	2.21	2.02	+ 11
Quaker State	759	529	.92	.64	+ 44	1,763	1,340	2.14	1.62	+ 32
Richfield Oil	7,495	4,856	1.86	1.20	+ 54	18,189	15,265	4.51	3.82	+ 19
Shell Oil Co.	34,868	35,161	1.15	1.16	— 1	104,055	89,032	3.44	2.94	+ 17
Signal O. & G.	3,866	4,425	.43	.49	— 13	12,525	12,751	1.38	1.40	— 2
Sinclair Oil Corp.	7,993	9,458	.52	.62	— 16	35,025	31,814	2.28	2.07	+ 10
*Sinclair Venez.	909	4,664	.23	1.16	— 81	7,091	13,309	1.77	3.32	— 47
Skelly Oil Co.	5,589	6,995	.97	1.21	— 20	20,111	17,544	3.50	3.05	+ 15
Socony Mobil Co.	45,900	46,400	.95	.96	— 1	123,000	109,400	2.54	2.26	+ 12
Standard, Calif.	61,962	71,008	.98	1.12	— 13	180,115	187,744	2.85	2.97	— 4
Standard, Ind.	27,338	34,026	.76	.95	— 20	106,189	86,449	2.97	2.42	+ 23
Standard, Ky.	4,440	4,141	1.70	1.59	+ 7	11,183	10,442	4.29	4.01	+ 7
Standard, N.J.	162,000	146,000	.75	.68	+ 11	477,000	395,000	2.22	1.84	+ 21
Standard, Ohio	4,670	6,038	.92	1.21	— 27	17,959	17,474	3.59	3.50	+ 3
Sun Oil Co.	10,177	11,062	.87	.94	— 8	32,151	22,622	2.74	1.93	+ 42
Sunray Mid-Cont.	10,847	8,829	.52	.45	+ 23	30,783	28,080	1.57	1.46	+ 10
Texaco, Inc.	96,893	89,100	1.63	1.50	+ 9	261,854	228,317	4.41	3.85	+ 15
Texas Gulf Prod.	783	907	.19	.22	— 14	2,875	2,524	.71	.63	+ 14
Texas Pac. C. & O.	1,541	1,813	.40	.49	— 15	5,183	4,166	1.33	1.13	+ 24
Tidewater Oil Co.	9,199	d607	.61	d.04	.....	27,832	d328	1.85	d.02	.....
Union Oil, Calif.	9,129	9,373	1.11	1.14	— 3	19,900	20,830	2.43	2.54	— 5
Union O. & G., La.	3,025	1,654	.64	.35	+ 83	9,700	5,745	2.05	1.21	+ 69
Universal Consol.	695	804	.72	.84	— 14	2,416	1,928	2.52	2.01	+ 25
Woodley Pet. Co.	951	753	1.11	.88	+ 26	2,706	2,034	3.17	2.39	+ 33
*Total 46 Companies	683,837	674,408	...	...	+ 1	2,021,413	1,747,442	...	...	+ 16

*Totals exclude Standard (N.J.) affiliates, Imperial and International, and Sinclair affiliate, Sinclair Venezuela.
d Deficit.

Areas of Activity in Northwest-Yukon Territories

Major discoveries spur huge play in Canadian North

Excellent oil and gas prospects, improved transportation and adequate drilling incentives are luring a growing number of operators to the Northwest-Yukon Territories

THE MOST NORTHERLY reaches of Canada, including the vast Arctic Island Archipelago, currently are receiving exploration attention reminiscent of the 1947 Leduc discovery which touched off one of the greatest oil and gas exploratory campaigns ever waged.

Millions of acres in the far north country are now being explored by ground parties, numbering about 70 at the peak of activity in July of this year. The following activity is now underway or being planned:

- Seven drilling rigs are expected to start probing the subsurface of Canada's far north early in 1960.

Sedimentary Basin of Western Canada Considered Favorable for the Accumulation of Petroleum and Natural Gas

This activity compares with two or three rigs at the most during the past five years.

- Imperial Oil Limited soon will drill 12 to 15 exploratory tests in the Northwest Territories. Two rigs now in the area will be used.
- Home Oil Company and Associates plan a three to four-well drilling program just north of the British Columbia border in close proximity to the Beaver River gas discovery.
- Pan American plans a follow-up program to the Beaver River test in the near future.
- D. T. Briggs and Associates plan an extensive exploration project on their huge spread of permit rights in the southern sector of the Northwest Territories.
- Lobitos Oilfields of Canada, backed by English capital, is expected to start a wildcat in the Arctic Islands. Report likely will be confirmed as soon as regulations governing island permits are released.
- Scurry-Rainbow Limited is training Eskimos to work in the drilling crew that will conduct an important wildcat test north of the Arctic Circle this winter.

At present, applications totaling more than 95 million acres in the Arctic Islands by more than 25 companies and individuals are pending.

The Dominion Government is now studying a number of proposed changes in regulations governing exploration of lands lying north of the 70th Parallel and, before granting the permits, is expected to issue new regulations.

Expected in the near future, these new rules probably will contain provisions such as deposits, of perhaps five cents per acre, and other commitments designed to insure good faith in conducting exploration work.

Development history. Although sporadic drilling and stratigraphic testing over the past decade or two yielded little encouragement in the Northwest and Yukon Territories, one significant fact could not be denied: The Norman Wells field, discovered by Imperial Oil Limited in 1920, and located in the Northwest Territories a short distance south of the Arctic Circle, still is producing.

After 40 years, the field currently has 62 flowing wells producing some 1,285 barrels per day from the Devonian formation at about 3,000 feet. This one field serves to remind exploration people that despite the very great problems and high cost of exploring and operating in this far north region, the chances for finding major accumulations of oil or gas always have been better than average.

Despite the potential of the area, it was not until 1956 that acreage under permit began to assume large proportions. In that year, some 4 million acres were held by major and independent companies. From then on permits were filed at a rapidly increasing rate, and involved such well known companies as Imperial, Shell, California Standard, Canadian Husky, Honolulu Oil, Scurry Rainbow, Western Decalta and many others. By the end of 1957, land under permit rose to more than 20 million acres.

By 1958, a full-blown land rush was underway. Shell Oil Company boosted its holdings to about 9 million acres. Imperial took up about 3.5 million acres, and Texaco Inc., British-American and Hunt Oil Company each took out more than a million acres. A total of 700 permits were taken out in 1958, adding up to some 42 million acres.

Why activity increased. Last year, two gas discoveries of major significance literally blew the lid off and set in motion a new surge of interest in the Territories. A Pan American Petroleum wildcat in the Beaver River area, in the late fall of 1958, blew out with an estimated daily gas flow of some 10 Mmcf while coring at 8,520 feet. Located about three miles south of the Northwest Territories (British Columbia border), and some 290 miles north of Fort St. John, this test finally was brought under control and currently is being deepened.

In the spring of 1959, at a location about 75 miles east-southeast of Beaver River, Gulf State Oil Company of Canada (an affiliate of El Paso Natural Gas Company) made a major gas discovery with a reported open flow potential of more than 6 million cubic feet daily through a 3/8-inch flow bean with 2,200 pounds per square inch flowing pressure. The well, Petitot River 1, found the production in Middle Devonian.

The same operator then drilled another wildcat in the Kotcho Lake region about 60 miles southeast of the Petitot strike. This well, completed early this year, and producing from the Middle Devonian also, was reported to have a fantastic open flow potential of more than 1 billion cubic feet daily.

Gulf States has released little information on the two discoveries,

but reports are that if follow-up drilling confirms the apparent magnitude of the strikes, a pipe line will be built to take the gas to the Fort St. John area about 285 miles to the south.

Arctic circle oil-gas discovery. Even before the extent of the foregoing discoveries could be evaluated a discovery of major significance was made in the Yukon Territory just below the Arctic Circle. A rank wildcat drilled by Western Minerals Limited, on acreage acquired under farmout from Peel Plateau Exploration Company late last summer, discovered gas along with strong indications of condensate in the Permo-Pennsylvanian at a depth of 4,250 feet.

The well, Western Minerals et al Chance 1, on formation tests, made condensate-bearing natural gas at a rate of 6 Mmcf daily from approximately 100 feet of zone. A second test flowed 8 Mmcf daily, but the mercury was blown out of the measuring device, indicating an even greater flow potential. Later estimates put the flow potential at about 10 Mmcf daily.

A test of an additional 35 feet of zone yielded frothy, light gravity oil which unloaded from the drill pipe. A smaller gas flow accompanied this last test.

On a drillstem test below 5,190 feet, a strong blow, decreasing to very light, along with 950 feet of clean, light gravity oil was recovered. Total depth of the well at the time was 5,225 feet.

Identity or location of the zone tested was not revealed by the operator. However, it represents a discovery of significance, since the previous tests, in which up to 10 Mmcf of gas along with a high gravity crude were recovered, were made at around 4,250 feet.

At the time of the Chance 1 discovery, the Dominion Minister of Natural Resources classed it as one of the largest in Western Canada, the first discovery in the Yukon Territories and the first in the far north since Norman Wells was discovered in the Northwest Territories in 1920.

This farthest north discovery falls just south of the Arctic Circle and is some 200 miles south of the MacKenzie River delta, 95 miles east of the Alaska boundary and 200 miles west of the Norman Wells field. The test is 50 miles south of the company's Peel Plateau Eagle Plains 1 wildcat drilled the previous year and abandoned after being drilled to more than 9,000 feet.

Folded Middle Devonian strata on one of the Arctic Islands. White beds are continental sandstone. Note evidence of structure.

Under terms of the agreement involving two separate land blocks totaling 13,400 square miles, Western Minerals was committed to spend about $5 million on exploration to earn an 80 percent stake in wells drilled. This exploration project has been underway for the past few years and many unique problems have been involved.

Each winter for the past few years the company has operated long tractor trains to move supplies on a day-and-night basis from Hay River outpost in northeastern British Columbia to the work site near the Arctic Circle. Drilling equipment was transported piecemeal and some 2,000 to 3,000 tons of supplies had to be hauled across snow and ice covered terrain. Rigging up on the Chance 1 was completed in June 1959.

Another important wildcat test, even farther north, and north of the Arctic Circle, will be drilled this winter. Scurry-Rainbow Oil Limited has been barging drilling equipment down the MacKenzie River to a location in the Grandview Hills area of Northwest Territories at a point about midway between Fort Good Hope and Fort McPherson. The drilling project, to be drilled by Peter Bawden Drilling, Ltd., drew industry attention earlier this year when it was announced Eskimos were being trained to work in the crew. The rig to be used is capable of going to 8,000 feet.

Arctic Prospects. Some factors favoring oil exploration in the Western Canada Arctic Archipelago include:

1. Favorable geological opinion covers the Arctic Coastal Plain, the Sverdrup Area of piercement domes, and the Parry Islands Fold Belt. The piercement domes of the area are considered to be similar to those of the Mexican Gulf Coast, which have yielded such prolific production. The Parry Islands Fold Belt is a chain of large anticlines and other favorable features.

2. The stable political climate in Canada which compares favorably with the rest of the oil producing areas.

3. The helpful attitude of the federal government toward inducing operators to go into the Arctic Islands, with every prospect of further inducement in the future.

4. The apparent feasibility of the shipment of oil production from the Arctic Islands, particularly to the Atlantic Seaboard in Europe and elsewhere, not only through some channels of navigation open in the summer, but also by submarine tankers throughout the year.

5. Prospects for improvement of air transport in the area.

There is world-wide interest in this Western Canadian Arctic sedimentary basin. Most of the international or other major operators are not at present represented in the area, although many show interest so great that it is believed there will be farm-

out deals available at an early date. Such deals would afford development work as may be justified.

From all indications, this area may well be the last oil land play of such dimensions in North America.

Arctic geology favorable. Geologically, the region of northern Canada is a potentially rich hunting ground.

The southern portion of the Northwest Territories is a continuation of the Northern Alberta-Northeastern British Columbia basin that already has yielded numerous significant discoveries. In the Canadian Arctic, almost the entire geologic column is represented in the sediments, ranging from Tertiary to Cambrian, with an aggregate thickness, some believe, of up to 50,000 feet, and can be divided into at least three important periods of folding.

One authority, whose company holds extensive acreage in the Arctic Islands believes the region has better prospects than Alberta had in the 1920's. Reportedly, interesting and significant outcrops along with numerous oil and gas seeps have been found in the region.

Access into the Northwest and Yukon Territories so far has been by riverways and tractor train. Once a rig has been set up, of course, air travel becomes the only practical way of bringing in supplies, particularly during the summer months.

A new road building program within a year or so will simplify moving of heavy equipment into the interior. One of the main segments of the project will be a 200-mile road extending from a point near Dawson to the vicinity of Eagle Plain Reservation.

Permafrost, muskeg hazards. Many of the ground parties in the field earlier this year registered amazement at the relative ease of operations in the Arctic. They were prepared for the worst, but found comparative ease of movement.

The lower areas are covered by muskeg. However, thanks to recently improved vehicles even this condition does not present too serious a hazard and is easily traversed in the winter.

Double credits for drilling. On each Arctic Island there are several applicants who are substantial operators (whose number could be increased by farm-outs), and thus it might be feasible to organize joint drilling ventures in the nature of deep exploratory tests, so as to earn double credits on the work requirements, and accelerate performance of that work and redemption of the performance bonds on deposit.

By reason of favorable amendments to regulations now being processed by government extending the 3-year permit period to six years, the cost of maintaining the right to these lands is remarkably less than the cost of maintaining other prospective, virgin oil lands, the geology of which is probably no better.

Thus, maintenance of lands other than these islands without double credits for drilling is 54 times as costly, and with double credits is 95 times as costly during the first three years, and similarly in the next three years. Table 1 shows an example of costs.

TABLE 1—Reservations in N.W.T. Sold March 1959 by Dominion Government

	Without Double Credits For Drilling	With Double Credits
Average price per acre... (top price $8.26)	$2.69	$2.69
Required work, 1st 18 mos.....	.05	.025
Required work, 2nd 18 mos.....	.25	.125
Total.....	$2.99	$2.840
Average per acre per year during first 3 years.....	99.67 cents	95 cents

Atomic cargo submarines. The industry is now accepting the inevitability of sub-sea cargo tankers. In addition to their ability to cruise beneath the protecting Arctic ice, cargo submarine hulls are cheaper to construct and are much faster than surface tankers. They would also allow shippers to take advantage of the much shorter trade routes via the Arctic Ocean.

The following news item from the June 27 Calgary Herald again indicates intention to develop cargo submarines to use the Polar route: "Essen (Nana) Krupp will build a diving chamber to be used by Auguste Piccard in experiments for the U.S. Navy intended to extend vastly operating depths for nuclear submarines . . . will conduct diving experiments at 15,000 feet . . . Krupp's interest . . . is enhanced by widespread German interest in cargo submarines which could use the Polar route to reduce distances."

Submarines are now operating at adequate depths for commerce at safe depths below the Arctic ice.

Relatively low relief and comparatively light snowfall in the far north regions make air travel particularly adaptable. Last summer, aircraft, of which about one-half were helicopters, were used extensively.

Exploration crews probably will be able to work at least six months of the year and, with the continual daylight of summer, working conditions will be even more favorable than those encountered in northern Alberta.

As the network of roads is extended, it may be possible to shift drilling equipment from northern Alberta and British Columbia to the far north areas, and thus actually balance out the over-all exploration season of Western Canada. At present, much of the far north work is crammed into a few months at freeze-up time.

Arctic permafrost can be either friend or foe to the exploration and drilling crew. In the transportation of equipment, the perpetually frozen tundra is an ally for, with only 8 to 10 inches of thawed soft tundra at the surface, tracked vehicles can travel with little difficulty.

If properly handled, the frozen ground is a friend during drilling operations. The usual method of supporting substructures is to melt holes in the "ground" to around 20 to 30 feet in depth, drop in large pilings and allow the watery mud to freeze solid. In a day or two, the pilings can be trimmed and the structure, either dwelling or rig base, then built on top of them.

From that point on, during drilling operations, other problems occur such as the thawing effect of warm drilling mud as it is circulated up past the 1,200 to 1,500 feet of permafrost. Not only does it present a hazard of losing the hole, but settling of the rig itself easily can occur.

These and other problems, however, have been encountered and overcome in Alaska and elsewhere in the far north, and they can be but temporary roadblocks in the path of those who continue to push northward. With proper planning and supplying of the far north projects the problems experienced today will become merely routine conditions tomorrow.

—The End

For Your PRODUCTION File

Here's how to improve your gas lift installations

PART 5: Estimating injection gas volumes used by intermittent wells

By H. W. Winkler, Engineer
Camco, Incorporated, Houston

AN EASY-TO-USE method has been developed which permits operators to estimate injection gas volumes used by intermittent wells with reasonable accuracy. The method is based on the volume of injection gas required to obtain a given pressure buildup in the casing during an injection gas cycle. The volume of injection gas per cycle can be estimated by calculating the volume of injection gas in the casing annulus immediately before the time cycle surface controller opens and the volume of gas in the casing at the instant the surface controller closes. The difference is assumed to be equal to the injection gas that passes through the operating gas lift valve during each cycle.

While the surface controller is open, any injection gas which enters the tubing through the operating gas lift valve is disregarded. In other words, the maximum injection gas pressure buildup in the casing immediately before the surface controller closes is assumed to be the operating gas lift valve opening pressure. Disregarding the small volume of gas which enters the tubing while the surface controller is open does not appreciably affect the actual gas used by an intermittent well if the length of gas injection is of short duration, and the increase in casing pressure during an injection period is at least 40-50 psi.

Measurement of injection gas for an intermittent well is difficult if a time cycle surface controller is used on the injection gas line. The maximum difference between line pressure and casing pressure occurs at the instant the surface controller opens. After the controller has opened, casing pressure begins to increase and line pressure generally decreases. Therefore, both the pressure difference across the motor valve, and the injection gas rate decrease.

Due to a lag in the differential pen of most types of orifice meters, the maximum differential at the instant the surface controller opens is not recorded. Before the differential pen can approach a value which would measure maximum injection gas rate into the casing, the actual injection gas rate has decreased as a result of casing pressure buildup.

If the volume of high-pressure injection gas upstream of the surface controller is adequate, the required duration of gas injection for a cycle will be short. For many intermittent wells, the time cycle surface controller is open for a minute or less for each injection cycle. When the duration of gas injection is short, an injection gas measurement using an orifice meter may be significantly low due to the lag of the differential pen. The procedure for estimating injection gas used by intermittent wells is ideally suited for those wells requiring only a short period of gas injection to lift the liquid slug.

The method also can be applied to intermittent wells which employ a small choke in the injection gas line if the gas lift valve or valves are open for a short time relative to the time required to increase casing pressure from the closing pressure to the opening pressure of the bottom valve. This type of intermittent operation is illustrated by the two-pen pressure recorder chart in Figure 10.

The volume of gas per thousand feet of casing annulus at the instant the surface controller opens or at the instant the surface controller closes (or gas lift valve opens and closes as illustrated by Figure 10) can be calculated using Equation 8 from Part 4 of this series (WORLD OIL, Page 122, November 1959). The capacity of the casing annulus must be substituted for the capacity of the tubing in the equation.

$$Q_s = \frac{P_{avg}}{Z_{avg}}\left[\frac{T_s}{T_{avg}}\right]\frac{V_{ca}}{P_s} \qquad (10)$$

FIGURE 8:
INJECTION GAS VOLUME PER 1000 FT. OF CASING ANNULUS AT VALVE OPENING AND CLOSING PRESSURES

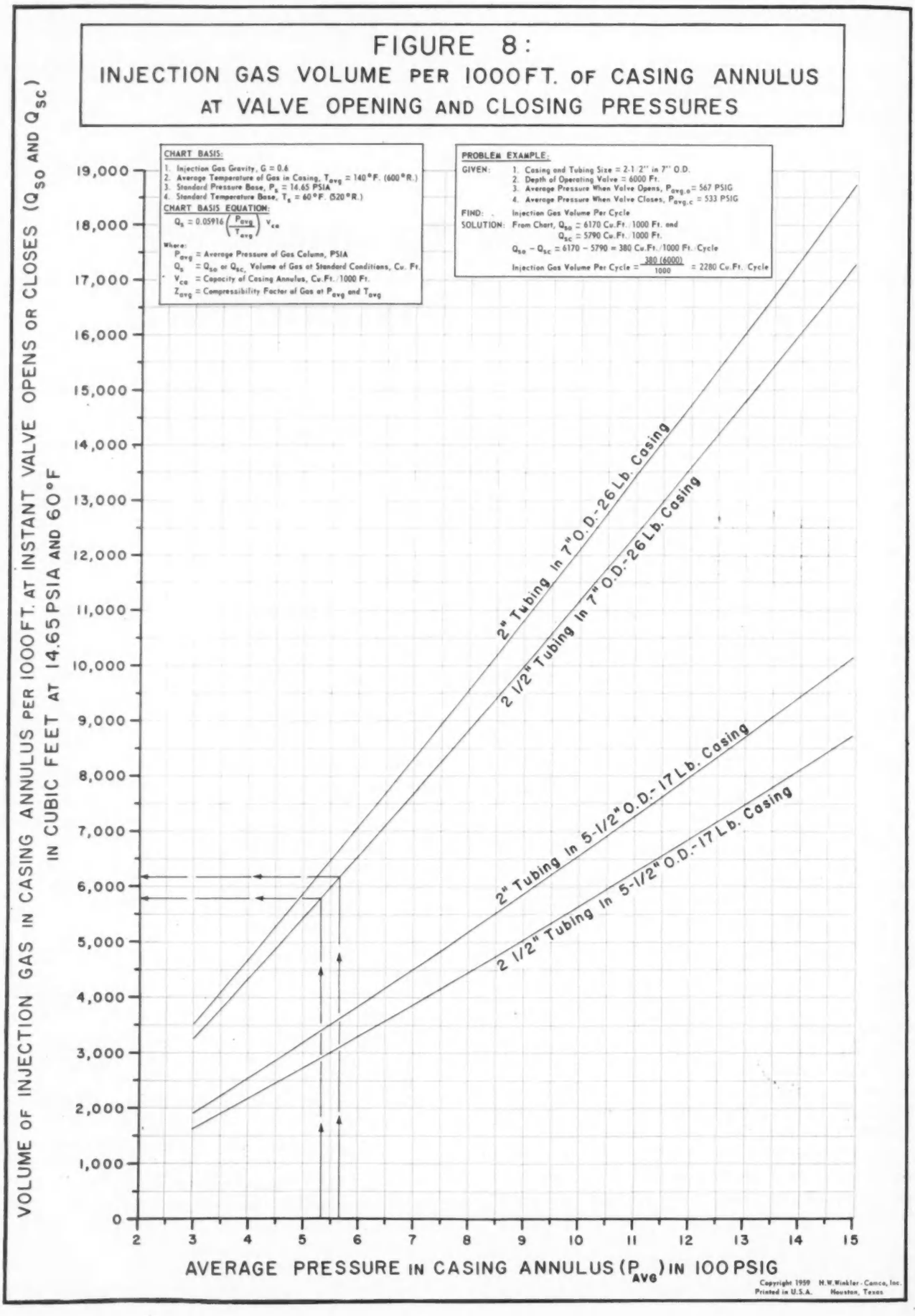


CHART BASIS:
1. Injection Gas Gravity, G = 0.6
2. Average Temperature of Gas in Casing, T_{avg} = 140°F. (600°R.)
3. Standard Pressure Base, P_s = 14.65 PSIA
4. Standard Temperature Base, T_s = 60°F. (520°R.)
CHART BASIS EQUATION:
$Q_s = 0.05916\left(\frac{P_{avg}}{T_{avg}}\right) V_{ca}$
Where:
P_{avg} = Average Pressure of Gas Column, PSIA
Q_s = Q_{so} or Q_{sc}, Volume of Gas at Standard Conditions, Cu. Ft.
V_{ca} = Capacity of Casing Annulus, Cu.Ft./1000 Ft.
Z_{avg} = Compressibility Factor of Gas at P_{avg} and T_{avg}
PROBLEM EXAMPLE:
GIVEN: 1. Casing and Tubing Size = 2-1 2" in 7" O.D.
2. Depth of Operating Valve = 6000 Ft.
3. Average Pressure When Valve Opens, $P_{avg.o}$ = 567 PSIG
4. Average Pressure When Valve Closes, $P_{avg.c}$ = 533 PSIG
FIND: Injection Gas Volume Per Cycle
SOLUTION: From Chart, Q_{so} = 6170 Cu.Ft./1000 Ft. and
Q_{sc} = 5790 Cu.Ft./1000 Ft.
$Q_{so} - Q_{sc}$ = 6170 − 5790 = 380 Cu.Ft./1000 Ft./Cycle
Injection Gas Volume Per Cycle = $\frac{380\ (6000)}{1000}$ = 2280 Cu.Ft./Cycle
VOLUME OF INJECTION GAS IN CASING ANNULUS PER 1000 FT. AT INSTANT VALVE OPENS OR CLOSES (Q_{so} AND Q_{sc})
IN CUBIC FEET AT 14.65 PSIA AND 60°F
19,000
18,000
17,000
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
2" Tubing in 7" O.D.-26 Lb. Casing
2 1/2" Tubing in 7" O.D.-26 Lb. Casing
2" Tubing in 5-1/2" O.D.-17 Lb. Casing
2 1/2" Tubing in 5-1/2" O.D.-17 Lb. Casing
2 3 4 5 6 7 8 9 10 11 12 13 14 15
AVERAGE PRESSURE IN CASING ANNULUS (P_{AVG}) IN 100 PSIG
Copyright 1959 N.W.Winkler - Camco, Inc.
Printed in U.S.A. Houston, Texas

Substituting and simplifying,

$$Q_s = 0.05916\left[\frac{P_{avg}}{Z_{avg}}\right] V_{ca} \qquad (11)$$

Where:

P_{avg} = Average pressure of gas column, psia
P_s = Standard pressure base = 14.65 psia
Q_s = Volume of gas at standard conditions, cu. ft.
T_{avg} = Average temperature of gas column = 600° R. (140° F.)
T_s = Standard temperature base = 520° R. (60° F.)
V_{ca} = Capacity of casing annulus, cu. ft./1,000 ft.
Z_{avg} = Compressibility factor of gas at P_{avg} and T_{avg}

The data for plotting the curves in Figure 8 were calculated using Equation 11 which is based on the assumptions noted above and an injection gas gravity (G) of 0.6. These assumptions are representative of the majority of intermittent gas lift operations in the Texas-Louisiana Gulf Coast and South Texas areas.

If the actual gas gravity and average temperature of the gas column differ significantly from the chart basis for Figure 8, the gas volume per thousand feet of casing for both the maximum and minimum casing pressure which occur during an injection gas cycle can be calculated using Equation 10. The difference between these two volumes will be the approximate volume of gas which was used during the injection gas cycle.

All gas volume calculations for a vertical column of gas should be based on the average temperature and average pressure of the gas column and not on surface or bottom hole values. For these calculations the average temperature (T_{avg}) can be calculated as follows:

$$T_{avg} = \frac{T_w + T_v}{2}$$

Where:

T_v = Temperature of gas at depth, °R.

T_w = Temperature of gas at surface, °R.

The average temperature of the gas column can be assumed to be the same for the high and low average pressures in the casing annulus. In other words, the average temperature is the same when the valve opens and closes.

The average pressure (P_{avg}) must be calculated for the low and high surface casing pressures before Figure 8 or Equation 10 can be used.

$$P_{avg} = \frac{P_w + P_v}{2}$$

Where:

P_v = Gas pressure at depth, psia

P_w = Gas pressure at surface, psia

If Equation 10 must be employed for estimating the gas used by an intermittent well, the compressibility factors (Z) for the average pressures can be obtained from Figure 1 which appeared in Parts 1 and 2 of the series (WORLD OIL, August 1, Page 65, and September, 1959, Page 75). The gas pressures at depth (P_v) can be determined from Figure 2 which also appeared in Parts 1 and 2.

If the actual injection gas gravity and average temperature of the gas column are the same as, or very nearly the same as, chart basis for Figure 8, the chart can be used for estimating gas volumes for all sizes of tubing and casing combinations, including duals. The following problem examples which include actual two-pen pressure recorder charts, illustrate the usefulness and accuracy of Figure 8 for estimating the injection gas used by intermittent gas lift wells.

PROBLEM EXAMPLE 1

The two-pen pressure recorder chart in Figure 9 was obtained from an intermittent well equipped with a time cycle surface controller on the injection gas line. The surface controller is open for approximately 60 seconds every hour. The injection gas line pressure is maintained between 600 and 650 psig which accounts for the rapid injection gas pressure build-up in the casing annulus after the controller opens.

The total depth of the well is 5,200 feet, and the operating gas lift valve is at a depth of approximately 5,000 feet. Since the operating value is the bottom valve and there is a packer in the well, the liquid level in the casing annulus is at a depth of 5,000 feet. The well is equipped with 2-inch tubing and 5½-inch OD, 17-pound casing.

The daily injection gas used by this well can be calculated as follows:

1. Determination of casing pressures from two-pen pressure recorder chart in Figure 9:
   Surface casing pressure when controller closes = 515 psig.
   Surface casing pressure when controller opens = 460 psig.
2. Determination of injection gas pressure at depth (Gas Gravity = 0.6 and T_{avg} = 125° F. or 585° R.):
   515 psig at surface increases to 572 psig at 5,000 feet.
   460 psig at surface increases to 511 psig at 5,000 feet.
3. Calculation of average pressure in casing annulus when controller opens and closes:

   When controller opens, $P_{avg} = \frac{515 + 572}{2} = 544$ psig

   When controller closes, $P_{avg} = \frac{460 + 511}{2} = 486$ psig

4. Determination of injection gas volume per thousand feet of casing from Figure 8 for 2-inch tubing and 5½-inch OD casing:
   When controller closes, Q_s = 3,470 cu. ft./1,000 ft. at 544 psig

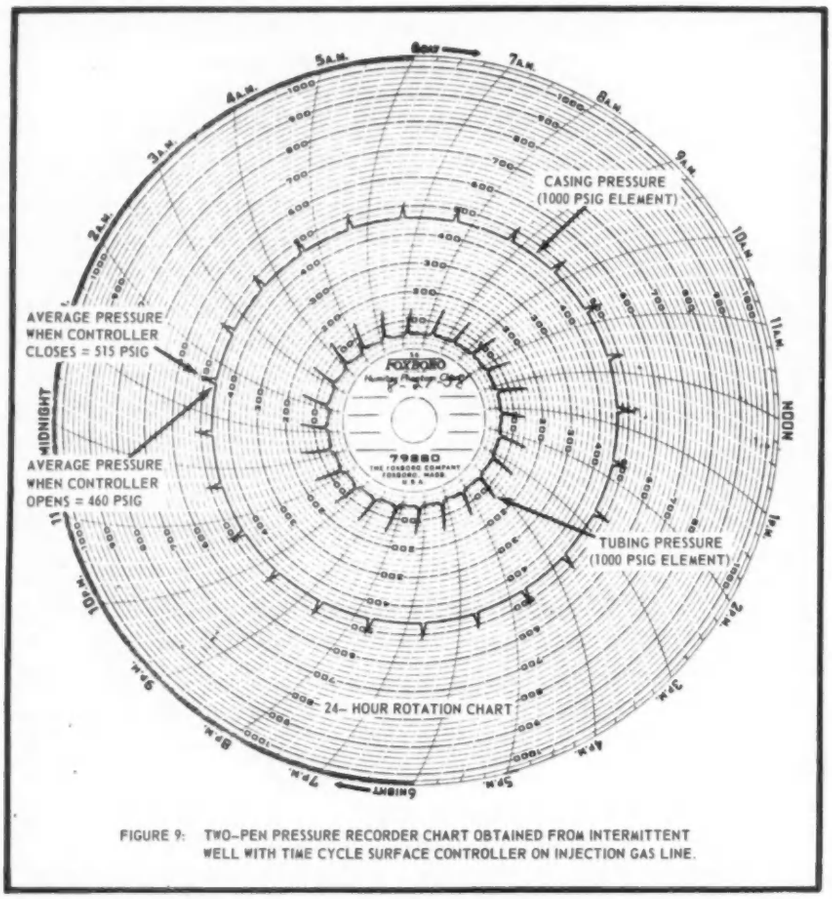


FIGURE 9: TWO-PEN PRESSURE RECORDER CHART OBTAINED FROM INTERMITTENT WELL WITH TIME CYCLE SURFACE CONTROLLER ON INJECTION GAS LINE.

TABLE 1*—Annular Capacities for Wells With One External Upset Tubing String

Casing Size O.D.—Wt. (in.)—(lb./ft.)	SIZE OF INNER TUBING STRING		
	1½" Nom. 1.900" O.D. (cu.ft./ft.)	2" Nom. 2.375" O.D. (cu.ft./ft.)	2½" Nom. 2.875" O.D. (cu.ft./ft.)
5½—17	0.111	0.0996	0.0856
6⅝—24	0.172	0.160	0.146
7 —26	0.195	0.184	0.170

Annular Capacities for Wells With Two External Upset Tubing Strings

Casing Size O.D.—Wt. (in.)—(lb./ft.)	SIZE OF INNER TUBING STRINGS		
	Two Strings of 1½" Nom. 1.900" O.D. (cu.ft./ft.)	1½" Nom. 1.900" O.D. 2" Nom. 2.375" O.D. (cu.ft./ft.)	Two Strings of 2" Nom. 2.375" O.D. (cu.ft./ft.)
5½—17	0.0915	.....	.....
6⅝—24	0.152	0.141	.....
7 —26	0.175	0.164	0.153

* Note:—Couplings and upsets are disregarded.

Previous articles in this series . . .

1. **Pressure at depth determinations**
   (August 1 WORLD OIL, *Page 63)*
2. **Simplified method for constructing gas pressure at depth curves**
   (September WORLD OIL, *Page 73)*
3. **Simplified valve spacing chart for intermittent gas lift design**
   (October WORLD OIL, *Page 159)*
4. **Injection gas requirements for intermittent lift**
   (November WORLD OIL, *Page 120)*

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These subjects will be discussed in coming issues . . .

- **The purpose and use of flow valve specifications**
- **How to hook up surface controllers for special gas lift applications**

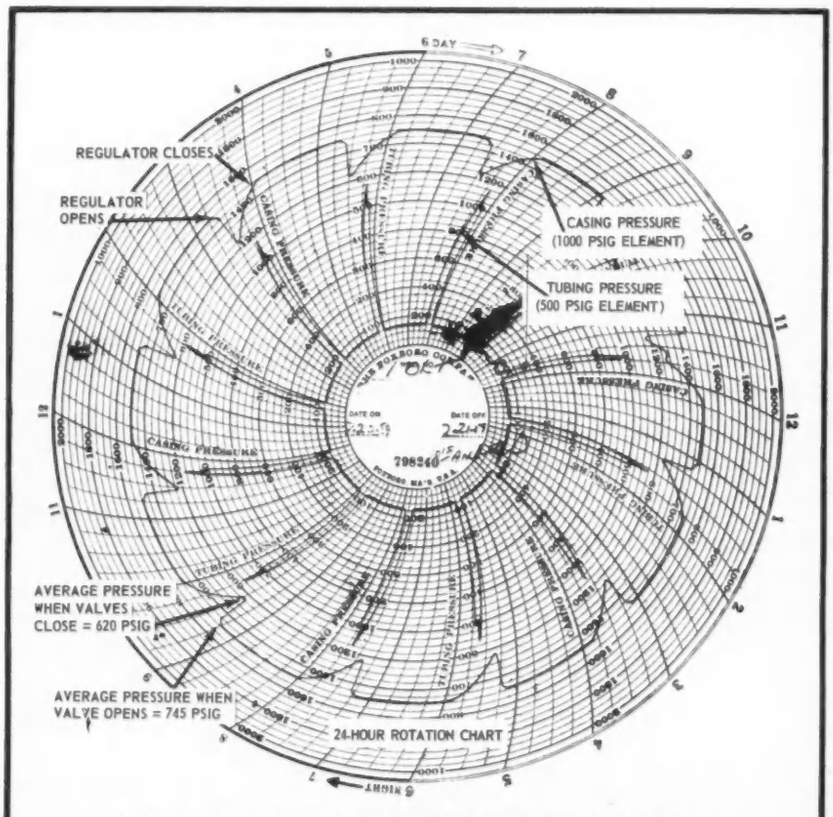


FIGURE 10: TWO-PEN PRESSURE RECORDER CHART OBTAINED FROM FLUID OPERATED INSTALLATION WITH PRESSURE REDUCING REGULATOR AND CHOKE IN INJECTION GAS LINE.

When controller opens, Q_s = 3,100 cu. ft./1,000 ft. at 486 psig

5. Calculation of injection gas volume used per cycle:

$$(3{,}470 - 3{,}100)\ \frac{5{,}000}{1{,}000} = 1{,}850 \text{ cu. ft./cycle}$$

6. Calculation of injection gas volume used per day:
1,850 cu. ft./cycle (24 cycles/day) = 44.4 Mcfd

This well actually uses approximately 50 Mcfd based on the total gas out measurement and the formation gas-oil ratio.

As mentioned previously, Figure 8 can be used for dually completed wells if the capacity of the casing annulus is known. Annular capacities of several tubing and casing combinations for both single and dual completions are given in Table 1.

PROBLEM EXAMPLE 2

This example is based on data obtained from a dually completed well in which only one zone is being produced to ascertain an operating injection gas casing pressure which will assure maximum production with minimum gas-liquid ratio. The two-pen pressure recorder chart in Figure 10 was obtained during a test of the upper zone while the lower zone was shut-in.

The upper zone is being lifted from the bottom fluid operated valve at 6,885 feet. The depth of lift was established by a bottom hole pressure survey. The valve at 6,885 feet is the deepest valve in the well; therefore, the fluid level in the casing is at 6,885 feet. The well contains two strings of 2-inch tubing in 7-inch OD, 26-pound casing which has an annular capacity of 0.153 cubic feet per foot (Table 1). Since no curve in Figure 8 was calculated for this tubing-casing combination, the volume of gas per cycle must be determined for a tubing-casing combination which is presented in Figure 8.

The volume of gas in a casing annulus for a given pressure is directly proportional to the capacity of the casing annulus. Therefore, if an injection gas volume per cycle for a given annular capacity is known, the gas volume per cycle for the same average casing pressures can be calculated for a different annular capacity if this annular capacity is given. The following example will illustrate these calculations:

1. Determination of casing pressures from two-pen pressure recorder chart in Figure 10:
Surface casing pressure when valve opens = 745 psig
Surface casing pressure when valves close = 620 psig

2. Determination of injection gas pressure at depth (Gas Gravity = 0.6 and T_{avg} = 140° F. or 600° R.):
745 psig at surface increases to 857 psig at 6,885 feet
620 psig at surface increases to 714 psig at 6,885 feet

3. Calculation of average pressure in casing annulus when valve opens and closes:

When valve opens, $P_{avg} = \frac{745 + 857}{2} = 801$ psig

When valves close, $P_{avg} = \frac{620 + 714}{2} = 667$ psig

4. Determination of injection gas volume per thousand feet of casing from Figure 8 for 2½-inch tubing in 7-inch OD casing (Annular Capacity = 0.170 cu. ft./ft.):
When valve opens, Q_s = 8,830 cu. ft./1,000 ft. at 801 psig
When valves close, Q_s = 7,290 cu. ft./1,000 ft. at 667 psig

5. Calculation of injection gas volume used per cycle for two strings of 2-inch tubing in 7-inch OD casing (Annular Capacity = 0.153 cu.ft./ft.):

$$(8{,}830 - 7{,}290)\ \frac{(6{,}885)}{(1{,}000)}\ \frac{(0.153)}{(0.170)} = 9{,}540 \text{ cu.ft./cycle}$$

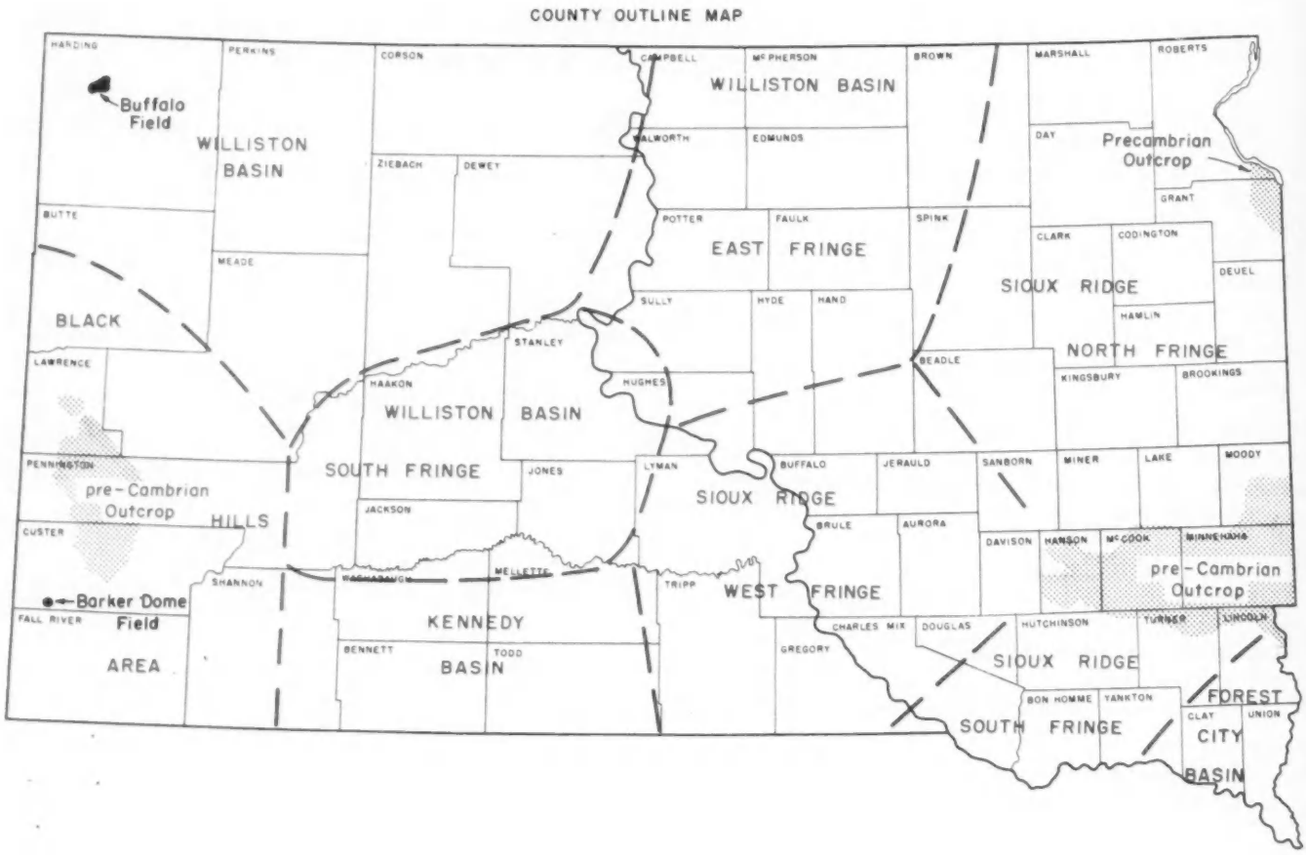
6. Calculation of injection gas volume used per day:
9,540 cu.ft./cycle (12 cycles/day) = 114.5 Mcfd

Actual injection gas input for this well during the time recorded on Figure 10 was approximately 123 Mcfd. The input gas was measured accurately since a small positive choke was used in the injection gas line. The pressure regulator on the injection gas line was open nearly 45 minutes (from the time the bottom fluid operated valve opened until the casing pressure reached the set regulator closing pressure).

This method can be used to estimate the gas used by an intermittent well with operation similar to that illustrated by Figure 10 because the time that the fluid operated valves are open is of short duration and there is a very small choke in the injection gas line. Since the choke in the injection gas line is small, as can be noted by the time required for the casing pressure to increase to the closing pressure of the regulator, the volume of gas which enters the casing while the fluid operated valves are open is not appreciable.

TO BE CONTINUED

This month's report on what's new in equipment, services and literature begins on Page 200



South Dakota oil prospects becoming

Mesozoic and Paleozoic beds show oil and gas in Williston Basin, Black Hills areas

By Dr. Allen F. Agnew
Director, South Dakota
State Geological Survey
Vermillion, S. D.

MANY AREAS and stratigraphic units remain untested in South Dakota, although at least 350 oil tests had been completed in the state by mid-1959. Facies and permeability traps, unconformities, folds and hydrodynamic conditions have helped localize hydrocarbons in South Dakota.

The Buffalo-Red River pool of Harding County appears to be a facies trap in combination with either structure or hydrodynamics or both. The Barker Dome-Leo pool of Custer County appears to be a combination facies-structure trap. These combination traps will continue to be sought.

Many of the oil tests in South Dakota have been located on seismic highs. In the Black Hills area, many tests have been drilled on seismic terraces or noses in combination with updip wedge-outs of Cretaceous sands. This combination, together with truncated units, might well be applied to the Paleozoic carbonates in the Williston Basin and shelf area with fruitful results.

A more systematic approach to drilling in the Black Hills area should be rewarding, especially in the southeastern part where the Black Hills-Chadron Arch structures are offset, and in the northeastern part where Pensylvanian and Mississippian shows have been reported.

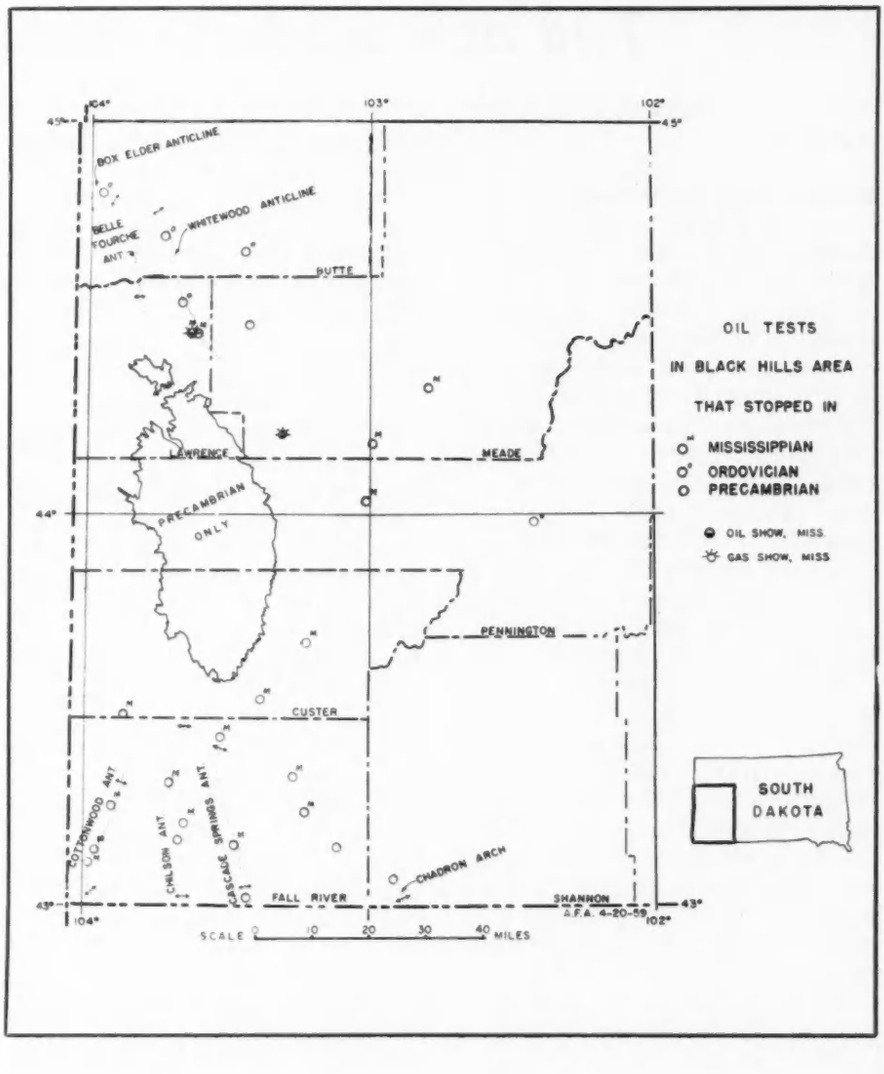
The area mapped as Kennedy Basin deserves further attention. So does the Forest City Basin area in the southeastern corner of the state. Outlines of these areas as shown in this article are somewhat arbitrary at present (Figure 1), and further information will undoubtedly result in shifting their borders.

The significance of gas in the Dakota sands of the central part of the state should not be overlooked.

South Dakota oil will not be found in "sheepherder anticlines". It will take well-planned systematic geological and geophysical exploration, possibly augmented by new techniques or combinations of methods not hitherto

FIGURE 1—South Dakota has a variety of potential oil and gas provinces (left). The Williston Basin and its fringes occupy the northwestern part of the state, and significant pumper oil production has been developed from Ordovician-age Red River carbonates in Buffalo field, Harding County. About 200 wells have been drilled in the area surrounding the Black Hills uplift, but few have been drilled to basement. Some oil production has been found in Carboniferous-age Leo sandstone. The Kennedy and Forest City basins extend into southern South Dakota from Nebraska.

FIGURE 2—Although about 200 wells have been completed around the flanks of the Black Hills uplift in South Dakota (right), only a small number reached basement rocks. Most of them tested the Cretaceous Newcastle or Fall River sands, productive in the Powder River Basin. Only about 50 of these wells had tested the Pennsylvanian Converse sands, and fewer still continued the additional 300 feet to test the Leo sands, oil-productive at Baker Dome in Fall River and Custer counties.



better known

tried. Because of the rather stringent economics of South Dakota oil, refinements in drilling and production methods must be sought.

Williston Basin and fringes. The Cedar Creek anticline, which has the Buffalo oil field along its eastern slope, is near the southwestern border of the Williston Basin. This basin has subsided sporadically and unevenly during the geologic pasts and facies changes and truncated edges are common. Because South Dakota is situated along the edge rather than near the center of the basin, only the northern parts of Perkins and Corson counties are truly basinal (Figure 1). These changes are not so evident as in the deeper part of the basin in North Dakota. Nevertheless, they occur in South Dakota and give rise to oil possibilities there.

Where the basinal facies grade into the shelf, lithologic changes are present in South Dakota in the following potentially productive sequences: the Triassic Spearfish sand, the Mississippian Charles, Mission Canyon, Lodgepole, Devonian, and Ordovician Red River carbonates. Detailed studies of many parts of the stratigraphic column are currently under way, and papers dealing with the Triassic-Jurassic, Mississippian, and Devonian have been published (Bibliography 1-7).

Irregular overlapping patterns of the successive geologic units have resulted in numerous truncated edges that are sites of potential accumulation.[8 and 9] Unconformities within the Pennsylvanian Minnelusa are an unknown entity because recent detailed stratigraphic studies are lacking except for one attempt.[10] However, shows of oil and gas in this sequence of clastic, evaporite, and carbonate rocks in central South Dakota, and production in the Powder River Basin make it appear worth studying here.

The Ordovician Winnipeg sand flows fresh water in most wells, but at least one oil show was reported from it in a Harding County well.

Gas shows in the Dakota sands in the Williston Basin shelf area of Central South Dakota indicate that further investigation of this sequence is worthwhile, and the State Geological Survey is engaged in a long-range subsurface project dealing with these rocks.

The Williston Basin and shelf area of South Dakota has revealed many oil shows (45 percent of the holes have logged shows) in the Mississippian and Ordovician carbonates, but

Two new producers have revived interest

this area has been very inadequately prospected.

Buffalo field development. Successful completion of two new producers about four miles apart in the Buffalo field, Harding County, in northwestern South Dakota, revived interest in the oil and gas possibilities of the state. These wells, completed in November 1958, were the Clarkson-Schlaikjer Government 1, and the Mid-America Minerals State 1-16, which followed completion of the three producing wells of Shell Oil Company. Two of Shell's wells were completed in 1954 and the other in 1957. At that time they were the only commercial oil producers in South Dakota.

The Schlaikjer well is 3½ miles across structure, updip from the Shell producers. Core analysis and pumping tests showed more fluid but less water than in the Shell wells. These considerations as well as indications of more favorable structure contribute to awakening interest in this and other areas in the state. All producers completed through midyear 1959 were on pump.

The upper Ordovician Red River dolomite has several zones of good porosity and permeability in various parts of Harding County. The Cedar Creek anticline, which is dotted with lower Paleozoic pools farther north, had been mapped as extending into at least part of Harding County. Shows of oil and gas had been found in several tests scattered throughout the northwestern part of the state.

However, permeability varied unpredictably with each succeeding well drilled in South Dakota. The first three Shell producers were not on the crest of the Cedar Creek anticline, so the structural picture was not clear. In addition, the water-to-oil ratio in the three producing wells was high.

Two companies had reportedly spent more than a million dollars each on exploration in Harding County alone. Early producing wells are said to have cost more than $250,000 apiece, and dry holes $150,000.

Other unfavorable factors which retarded exploration included thin pay sections—8 to 12 feet—containing much water and a little gas at about 8,500 feet. A 100-mile truck haul and a rail haul were required to move the oil to market.

In March, 1959, the area that includes the Shell and Mid-America wells and the Clarkson-Schlaikjer extension was defined as the Buffalo Field and brought under 160-acre spacing by the State Oil and Gas Board. The board adopted this spacing in recognition of the high well cost, and because the larger spacing allows more efficient oil drainage from the Red River reservoir. This spacing and other field rules assure orderly development. Since the 160-acre spacing was ordered, the Clarkson-Schlaikjer well has been offset by their Graves 1, and the Shell and Mid-America wells have been offset by Shell's 14-16 State and Mid-America's 2-16 State (all producers). * (Editor's Note: Since this manuscript was received, four additional producers have been added in the Buffalo field proper —Shell's 14-09, 14-17, and 32-09 State, and Mid-America's 3-16 State. Two additional wells are now producing to the west—Carter-Argo State 1 and Carter Travers 1.) Shell since has stepped out southward along strike 3 miles with its 14-28 Haivala, and another 4 miles with the 12-11 Tilus. The two Shell step-outs have given additional data about the possible extension of the pool along strike, and as each new hole adds much necessary information, it appears that a rather extensive exploratory and development program is warranted. *(A third step-out, five miles farther southeast, produced only salt water, as did another 1½ miles southwest of the Carter Travers 1.)

Casing collapsed at Shell's 32-17 Graves, apparently at the horizon of the Jurassic (?) Pine Salt. This well, and the two earlier Shell-State wells, were drilled with fresh-water mud. Subsequent holes have been drilled with salt-saturated (300,000 ppm) mud below the Sundance.

Production of 195,420 barrels of oil to June 1, 1959, has been obtained from the Red River zone between 35 and 55 feet below its top. Pay zone thickness ranges from 12 to 18 feet in the recently completed wells.

Surface casing, usually 10¾- or 9⅝-inch, is run at about 750 feet. Normal completion practice includes setting 5½-inch or 4½-inch casing to just below the base of the producing zone, and perforating a 2-to-10 foot interval. Breakdown acid (250 gallons) generally precedes a 1,000-5,000-gallon treatment.

A more recent development is the possibility of production from the upper permeable zone (U_2-U_3 of Shell) of the Red River. Base of this zone is 15 to 20 feet above the top of the main producing horizon. The Clarkson-Schlaikjer wells and the Shell 12-11 Tilus showed this zone has both permeability and oil. This zone was swabbed in the Shell Tilus well.

Black Hills area. The Black Hills area is an uplift whose borders are closely related to at least two adjoining basins—the Williston on the north and Powder River on the west; and in an extended sense to two others—the Denver-Julesburg to the south and the Kennedy to the southeast.

Although nearly 200 oil tests have been drilled in the Black Hills area, most of them tested only the Cretaceous Newcastle or Fall River sands, which are productive in the Powder River Basin. Significant oil and gas shows were found in Fall River County and the eastern part of Custer County.

Furthermore, only 50 of these 200 tests reached the potentially productive upper Pennsylvanian Converse sands in the northern Black Hills, and fewer still went the extra 300 feet necessary to test the Leo sands, which are productive in the Powder River Basin and provide the oil in the Barker Dome-Leo pool of southwestern Custer County.

The Mississippian Pahasapa limestone was touched by only about 10 percent of Black Hills area wells. Its oil potential is thus unknown, although it is the source for many flowing water wells in the area, and had oil and gas shows in the northern part of the Black Hills.

Kennedy Basin. This area of South Dakota is a "great unknown." Only two oil tests had been drilled. Both penetrated a thick clastic section below the Morrison shale. Nearby tests in the Nebraska part of this

in NW South Dakota

basin have reported shows from the Pennsylvanian.

Sioux Ridge. Precambrian Sioux quartzite constitutes bedrock of Sioux Ridge either at the surface or just under the glacial drift. The area north of the ridge has received only five oil tests, most of which went into the Precambrian directly below the Dakota sequence.

The area northwest, west and southwest of Sioux Ridge has had nine oil tests, all of which reached the Precambrian. Four of these holes were drilled in Tripp County and showed interesting thin sections of varied Ordovician rocks below Pennsylvania clastics. Water wells in this area have had gas and oil shows, presumably in the Cretaceous Codell sands, although these may be related to the Niobrara gas shows that are present not only in this area but also in other parts of the state.

The area south of the Sioux Ridge has been drilled for oil or gas at 11 locations, and shows of oil or gas have been reported from the Codell sand in several tests. The Precambrian in this area directly underlies the Dakota.

The area south of the Sioux Ridge is well known as the location of an oil test that penetrated at least 3,520 feet of Precambrian Sioux quartzite and slate 15 years ago. For those interested in the oil possibilities of the Precambrian, several shows of gas, light oil and tarry oil were reported, the deepest being 1,800 feet below the top of the Precambrian.

Forest City Basin. The area termed Forest City Basin is especially interesting in that a Lower Paleozoic variable sequence of Cambrian, Ordovician and probably Devonian clastic and carbonate rocks is present between the Dakota and the Precambrian. Oil shows were reported in five of the seven holes drilled.

General Data. The basal (Sharon Springs) bituminous shale of the Pierre has given oil and gas shows in many parts of the State, as has the underlying Niobrara. The Greenhorn and Minnekahta limestones, likewise, have had gas shows especially in western South Dakota. However, these are probably not related to significant local accumulations of hydrocarbons, but rather represent regional source rocks.

About the Author

Dr. Allen F. Agnew is state geologist and director, South Dakota Geological Survey, and professor of geology, University of South Dakota at Vermillion, S. D. He graduated with highest honors in 1940 from the University of Illinois and received his M.S. and Ph.D. degrees from the University of Illinois (1942), and Stanford University (1949), respectively. He has had broad experience in geological work, not only with the South Dakota Geological Survey, but with the Illinois and the U.S. Geological surveys. Dr. Agnew taught geology at Stanford University and the University of Alabama. He is the author of various publications on micropaleontology, stratigraphy, structure, lead-zinc deposits, geomorphology and general geology.

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PART 2

Geologist's interpretation of drilling mud requirements

The types of logs desired should be considered when designing a drilling mud program

By Dr. Hamilton M. Johnson, Geology Department
Tulane University, New Orleans

GEOLOGISTS ARE continually faced with the task of finding new hydrocarbon producing areas. Consequently, the oil industry must make available to the Exploration department any tools or methods that might improve this search.

Continual emphasis has been placed on decreasing drilling costs, and immense strides have been made in that direction. However, occasionally it has been done at the expense of proper evaluation of the horizons penetrated.

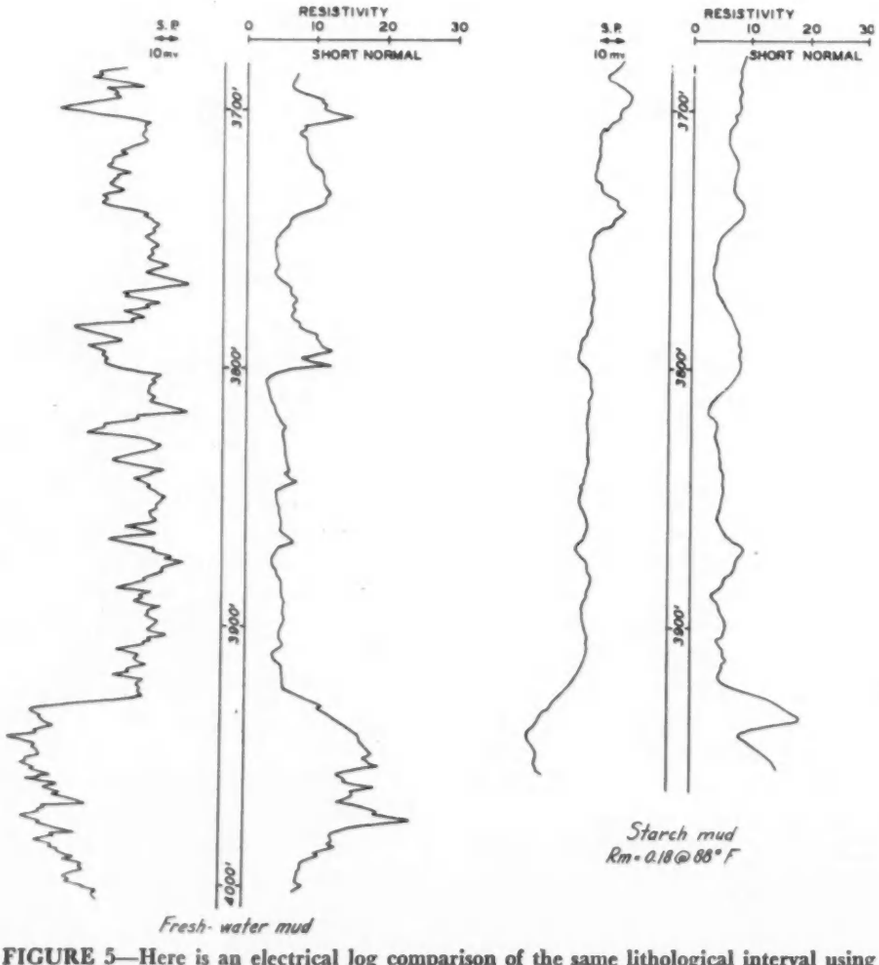


FIGURE 5—Here is an electrical log comparison of the same lithological interval using a fresh-water mud and a starch mud.

Mud programs must be designed not only for improving drilling and hole conditions but also must be adequate to reflect good electrical logging environment and lithology evaluation. Consequently, it behooves the oil operator to consider all facts when designing a drilling and exploration program.

Several different types of muds and the logging characteristics will be discussed showing their respective relationships.

3. Calcium-treated muds. Calcium-treated muds are very useful in areas of deep drilling, high-pressure gas, and heaving shales. They have low viscosity and gel strength so that they may be degassed easily, permit high circulation rates without excessive pressure, and permit rapid withdrawal of drill pipe without excessive reduction in fluid level. Shales do not readily hydrate, so higher mud weights are economical. The muds are stable and salt or anhydrite contamination is not critical.

A. Red lime mud. This is the usual lime-treated mud containing caustic, organic thinner, slaked lime, and some water-loss reducing agent. The pH is maintained between 10.5 and 12.0. At high temperatures, it is more effective when less lime is used than is needed for saturation.

Lime muds are usually very low resistivity muds because of the introduction of the $Ca(OH)_2$ and caustic (NaOH). The presence of free calcium and sodium ions in the muds naturally provides an excellent path for electrical current and lowers the mud resisitivity. Since there are varying concentrations of these chemical additives used to meet different drilling problems, the extent of decrease of mud resistivity will not be constant. The exact mud resisitivity may be calculated from a knowledge of

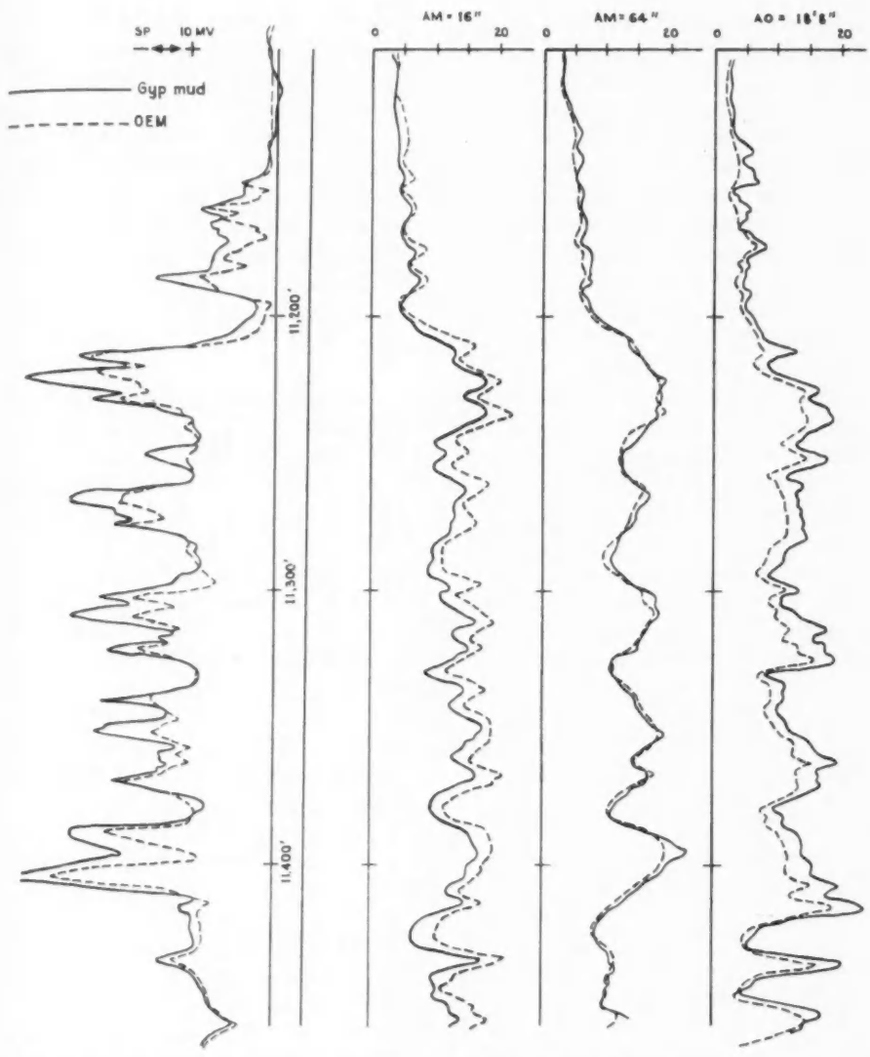


FIGURE 6—These curves were superimposed showing the difference of an electrical logged zone using a "Gyp" type mud and an "oil-emulsion" mud.

the chemical components and their concentration. It has been found, through a study of ionic activities, that the more common components lower the resistivity in the following order (from maximum to minimum effect): magnesium, carbonate, sodium chloride, sulphate, and bicarbonate.

The lime mud has the same effect on the conventional electric log as would any very low resistivity mud (i.e., the salt water mud). A very good example of this is shown in Figure 11. The oil-stained sandstone indicated by a conventional electric log recorded in fresh mud is completely masked on the conventional electric log recorded in a saturated lime mud. For this reason, the recommended logging program would again be use of Laterolog, MicroLaterolog, and Gamma Ray. The starch frequently used with lime muds as a water-loss control agent may nullify or reverse the S.P. anomaly

B. **Calcium chloride muds.** The most commonly used calcium chloride mud is said to be composed primarily of calcium chloride, lime and calcium lignosulfonate. If true, this should yield a mud which is of low electrical resistivity (although probably not so low as a straight lime mud). The filtrate may fluoresce somewhat similarly to crude oil; this has been true of some of the lignins and lignosulfonates. The mud has high gel strength and was developed for drilling in areas of anhydrite and salt, due to its resistance to contamination. Since the presence of free calcium ions in the filtrate retards shale hydration, it has also been recommended for drilling very thick shale sections.

The manufacturer recommends that "chloride analysis should generally show 4000-5000 ppm chloride." This statement is made in regard to chemical tests in maintenance of the mud. If the Cl content is this high, the equivalent NaCl concentration must be much higher—and if the Cl content was 5000 ppm, the mud resistivity would be 0.56 ohm-m at 150° F. Therefore, by its nature, this is a low resistivity mud and, as was recommended for the other low resistivity muds, the logging program should include Laterlog, MicroLaterolog, and Gamma Ray curves.

C. **Gyp muds.** The principal variation in this mud is the substitution of calcium sulphate (gypsum) for calcium hydroxide (slaked lime) to remove some of the objectionable properties of the usual lime mud. This substitution resulted in a mud characterized by high gel strength and viscosity. With these properties, some thinner was constantly required and water was the only one available. The constant addition of water was not compatible with the mud weight requirements for deep drilling. A new thinner has now been developed which is a synthetic dispersant, permitting gel and viscosity control of heavily weighted gyp muds. This thinner is a ferrochrome lignosulfonate derived as a by-product of the pulp-paper industry. The preparation and maintenance of a gyp mud is similar to that of a lime-treated mud. A native mud system may be converted to a gpy mud by the addition of caustic soda, gypsum and carboxymethylcellulose. The gypsum acts as a source of calcium ions and the high calcium-ion content of the filtrate reduces hydration of the shales and permits the drilling of close-to-gage holes.

The lime mud usually contains slaked lime in excess of the quantity needed for saturation, approximately 1½ to 2 pounds/barrel of caustic, some organic thinner, and a water-loss control agent. The gyp mud usually contains a concentration of gypsum considerably less than the quantity needed for saturation, only about 0.2 to 0.3 pounds/barrel of caustic, and some organic thinner and a water-loss control agent. Thus the gyp mud is considerably less alkaline, which should result in a higher mud resistivity and consequently better electric logs. The thinner and water-loss control agent should not affect the mud resistivity in any way.

The use of carboxymethylcellulose as the water-loss control agent is sat-

isfactory from the logging standpoint, if a pure additive is obtained. Some of the commercial carboxymethylcellulose additives have a high NaCl content. If pre-gelatinized starch plus some preservative is used, there may be a reduction in the S.P. anomaly shown in Figures 3 and 5.

The use of a lignosulfonate as thinner should not affect the resistivity but may be fluorescent in the filtrate. This has been true of some of the lignosulfonates and powdered lignites and must be anticipated here.

Actual results in a well are shown in Figures 6 and 7. This well was drilled to a depth below 12,500 feet using a normal oil-emulsion mud. A conventional electric log and a MicroLog were recorded at this depth. Mud resistivity was 1.30 ohm-m at 113°F. The mud was then changed over to a gyp mud, prepared according to the manufacturer's specifications. The hole was then drilled deeper with the gyp mud; the mud resistivity was 1.25 ohm-m at 92°F. A conventional electric log and a MicroLog were recorded, overlapping the previous run by several thousand feet. Figure 6 shows each of the curves of the conventional electric log traced in superposition for the two logs. A study of these curves indicates that there are more differences in the S.P. curve than in any of the others. The base line (shale line) is the same for the two curves but the magnitude of all anomalies is greater for the "gyp" log than for the "oil-emulsion" log. While the two logs were recorded 10 days apart, it is not obvious how the time lapse could cause the increased magnitude; it would seem more likely that any increased invasion by mud filtrate would have decreased the magnitude of the anomalies. The almost exact duplication of measurements by the long normal resistivity curves would indicate that very little additional invasion has taken place. The patterns of both the short normal and lateral resistivity curves are identical for the two logs but the magnitudes vary slightly, being less for the gyp mud on the short normal and greater for the gyp mud on the lateral. The difference is so slight that it may represent no more than differences in zeroing and response of the galvanometer systems.

Figure 7 shows each of the MicroLog and MicroCaliper curves traced in superposition for the two logs. A detailed study of the MicroCaliper shows a further sloughing in the shales and a build-up of mudcake opposite the sands with the passage of time. This is certainly what should have been anticipated.

The resistivity measured by both the micronormal and the microinverse curves is lower for the gyp mud. Since the mud resistivities (and probably the mud filtrate and mudcake resistivities) are approximately equal, this decrease must be attributed to the thicker mudcake and greater sloughing rather than to mud variation.

Calculations of the porosity of the sand between 12,500 feet and 12,550 feet yield 14 percent from the measurements in oil-emulsion mud and 13 percent from measurements in gyp mud; this is certainly within the limits of computational error and would indicate that either log may be used satisfactorily for this purpose. The very thin nature of the mudcake at the time of recording the log in oil-emulsion mud is probably due to the fact that the sand had just been drilled. The fairly thin mudcake (less than ¼ inch) produced by the gyp mud after drilling for ten days would indicate that this mud may be favorable for the MicroLog.

4. Oil-emulsion muds. This term is applied to any water-base drilling fluid containing oil in a stable form, so that it does not separate from the mud. It may or may not contain chemical additives such as lime, starch, etc., but some emulsifying agent is necessary to stabilize the mud. These emulsifying agents may be soaps, lignin compounds and lig-

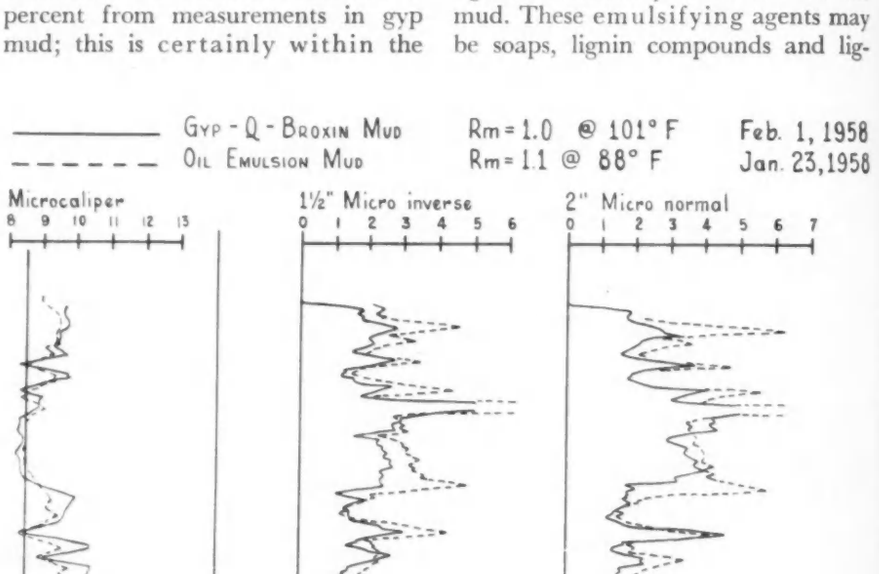

Gyp - Q - Broxin Mud
Rm = 1.0 @ 101° F
Feb. 1, 1958
Oil Emulsion Mud
Rm = 1.1 @ 88° F
Jan. 23, 1958
Microcaliper
8 9 10 11 12 13
1½" Micro inverse
0 1 2 3 4 5 6
2" Micro normal
0 1 2 3 4 5 6 7
12,500'
12,500'

FIGURE 7—Here is a superimposed MicroLog curve showing their respective relationship while using a Gyp-Quebracho Broxin mud and an oil-emulsion mud.

nosulfonates or organic colloids. The type of oil used varies, ranging from straight field crude through diesel oil to a special non-fluorescent oil.

It has been found that the advantages of oil-emulsion muds are:

- Reduce wear on bits, thus increasing bit life and speeding drilling.
- Save power by reducing torque.
- "Freeing-up" the hole.
- Reduce balling and caving.
- Aid production because they lower fluid loss, avoid water and mud blocking, lower surface tension, and protect the shales of the productive zone.

The mud itself seems to retain more or less the same electrical characteristics as a similar water-base mud without the emulsified oil. This is because the continuous phase is water, with each minute bubble of oil surrounded by a water envelope which provides a path for the logging current. It is probable that the addition of diesel oil or crude oil will increase the resistivity slightly more than the addition of a prepared oil-emulsion. The filtrate from these muds and the cake formed by this filtering action do not seem to follow the usual resistivity relationships with the parent mud which hold for clay water-base muds. Therefore, these properties must be individually measured on every well.

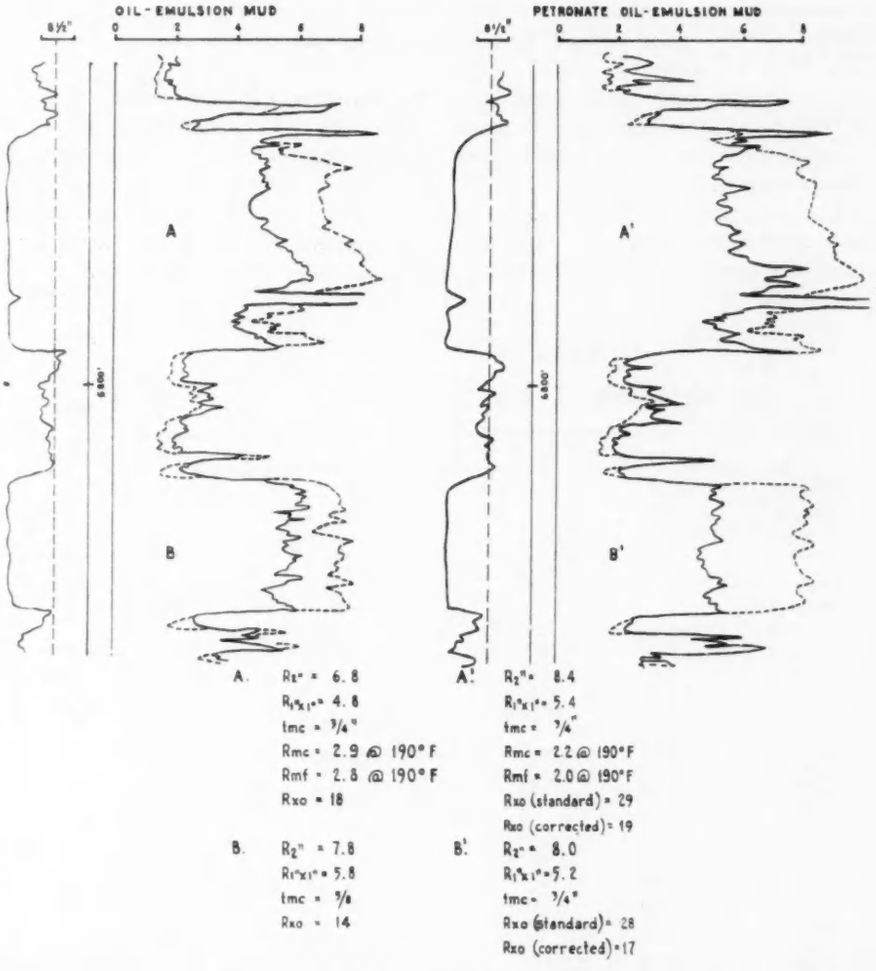


FIGURE 8—Here is a comparison of a MicroLog of the same lithological interval while using an oil-emulsion mud and a petronate oil-emulsion mud.

A lignosulfonate emulsifier developed by Mene Grande is fairly widely used in Eastern Venezuela. This gives a somewhat different mud-cake and special curves must be used in the quantitative analysis of MicroLogs made in this mud (See Figure 8). The qualitative interpretation of all of these oil-emulsion muds is the same as for any fresh-water mud. This feature is illustrated on Figure 9.

The principal geological objection to the use of oil-emulsion muds has been due to the masking effect on actual hydrocarbon shows in conventional cores, sidewall cores, and fluoroscopic examination of the mud stream in mud logging. Naturally, the introduction of any oil into the borehole by means of the mud stream will tend to make the direct determination of formation oil more difficult. If it is desirable to flush a core and make a gravity check of the contained oil, the oil used in drilling should differ in gravity from that anticipated in the reservoir. If study is being done by fluoroscopic analysis, a refined (usually diesel) oil may be used. This is only an intermediate solution, for some crudes fluoresce very similarly to diesel oil and the slight variation may change as the ratio of crude to refined varies in a series of cores. The best possible solution would be to use non-fluorescent oil as the oil content, thread lubricant, and non-fluorescing emulsifier. These are more expensive but do not fluoresce. Use of any of the mined lignites, lignosulfonates, soap type emulsifiers, etc. may produce a filtrate which fluoresces.

5. Oil-Base Muds. Oil-base muds are of two general types; in both, oil is the continuous phase. The older of these, generally called "oil-base," contains only some 2-5 percent water, held very tightly. The newer type, referred to as an "inverted emulsion" or "water-in-oil emulsion," contains about 20-70 percent water emulsified in the oil.

Neither of these muds will water-wet the formations. Viscosity is usually high but fluidity and pumpability are good and gel strength is low. These highly specialized muds are most often used for completion in water-sensitive producing horizons, for workover fluids, for use when gun-perforating, and for drilling salt and anhydrite sections.

The "inverted emulsions" are cheaper, easier to handle and less hazardous than oil-base muds; but are more expensive, more unstable, and more hazardous than conventional water-base muds. Therefore, they are not recommended for general use.

The oil-base muds and the "invert emulsion" muds are electrically non-conductive and the only electrical log obtainable in these muds is the induction log. However, use of the induction log and the Gamma Ray curve gives very useful information in regard to formation lithology and saturation. In Figures 10 and 11, it

is seen that the qualitative interpretation can be made almost equally well from either the conventional electric log in fresh water sand, due to difference in invasion and a more accurate measurement of true formational resistivity.

The very low fluid loss from oil-base mud allows cores to approximate the virginal oil/water ratio, so that better core analysis may result from coring in this fluid.

6. Sodium silicate muds. These muds are used primarily for the control of heaving shale or high pressure salt water flows. Silicate mud was designed to reduce hydration and consequent disintegration of the shales. Contamination by salt water causes almost no change in the physical properties of these muds. The mud is a water solution of sodium silicate and sodium chloride with such other additives as clays (for gel strength) and barium sulphate (for weight). The minimum mud density obtainable is 12 pounds per gallon. The mud is very expensive and fluid loss is high.

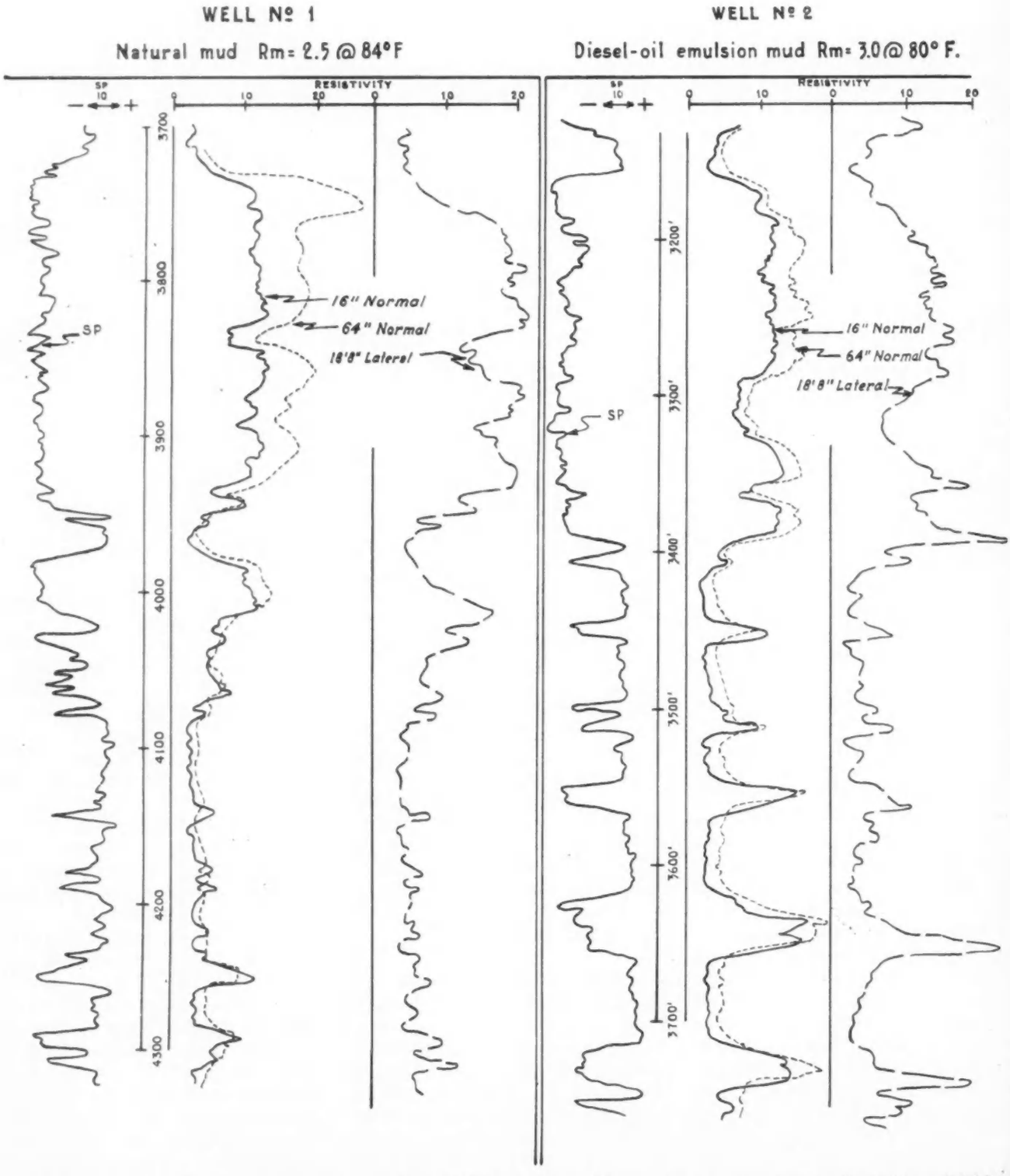
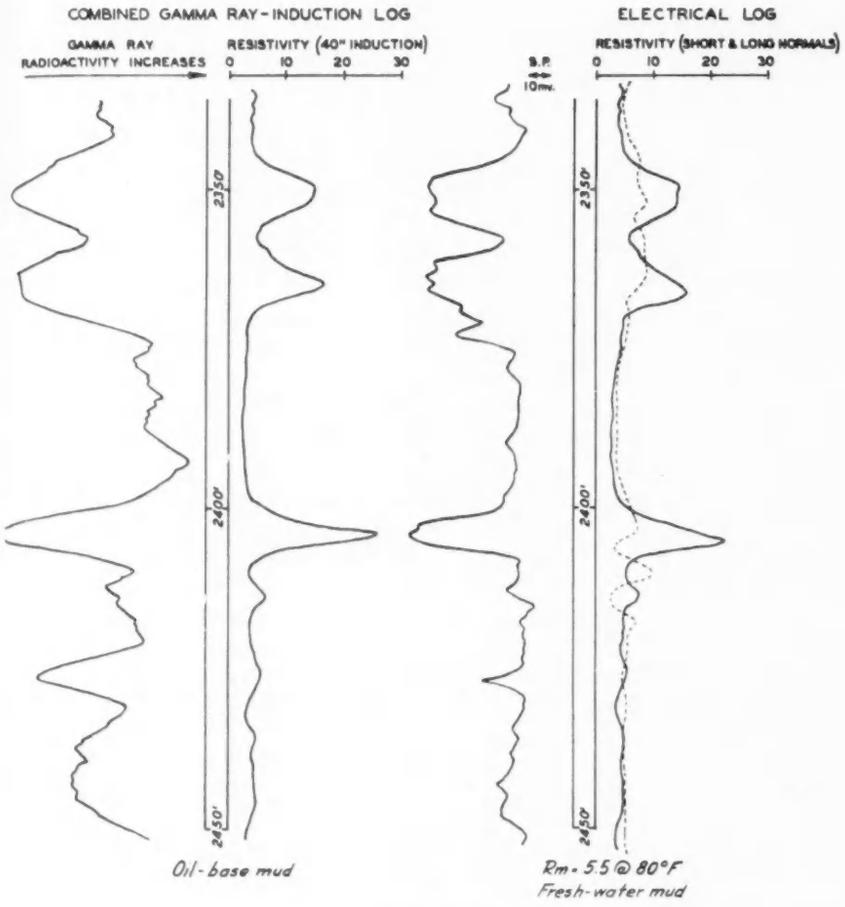


FIGURE 9—Here is shown a comparison of two wells drilled with an oil emulsion mud and a natural mud with similar resistivities.



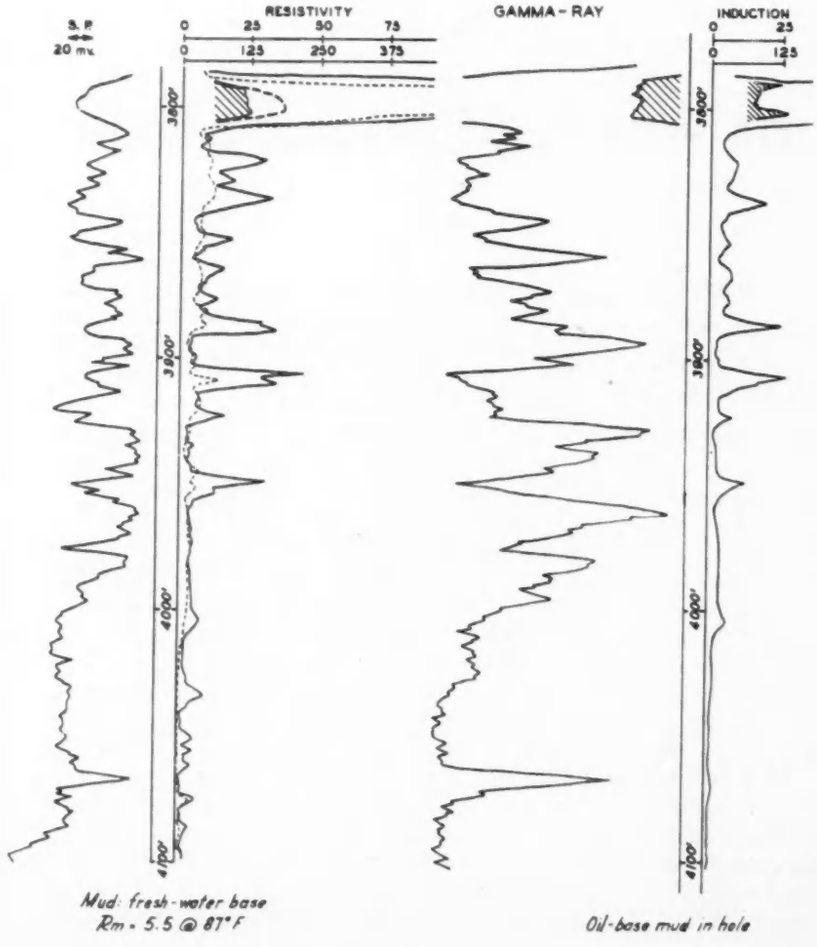


FIGURE 10—(upper left) **A difference in log characteristics is shown while changing over from oil-base mud to a fresh-water mud.**

FIGURE 11—(lower left) **Here is shown a conventional electrical low in fresh-water and a gamma ray induction log in an oil-base mud.**

About the Author

Dr. Hamilton M. Johnson, professor of geology and geophysics at Tulane University, New Orleans, received his B.S. in physics and chemistry at L.S.U., his M.S. in physics and electrical engineering from the same university and his Ph.D. in geology and geophysics from the University of Oklahoma. He has had 20 years of field experience in the United States, Mexico and Venezuela. His most recent position was well logging coordinator for Creole Petroleum Corporation at Caracas, Venezuela. He was with Schlumberger for over 10 years and organized a well-logging division for Seismograph Service Corporation and managed it for several years. Before going to Tulane he taught physics at Purdue and geology at the University of Oklahoma. He is the author of some 20 technical papers in the well logging field.

Due to the high content of NaCl included, this is a very low resistivity mud. The logging techniques used would include the Laterolog, Micro-Laterolog, and Gamma Ray, as is customary for any low resistivity mud.

(This article is based on a paper presented at the Third Annual Petroleum Conference on Well Logging Interpretations, School of Business Administration, McMurry College, in Abilene, Texas, October 15-17, 1958.)

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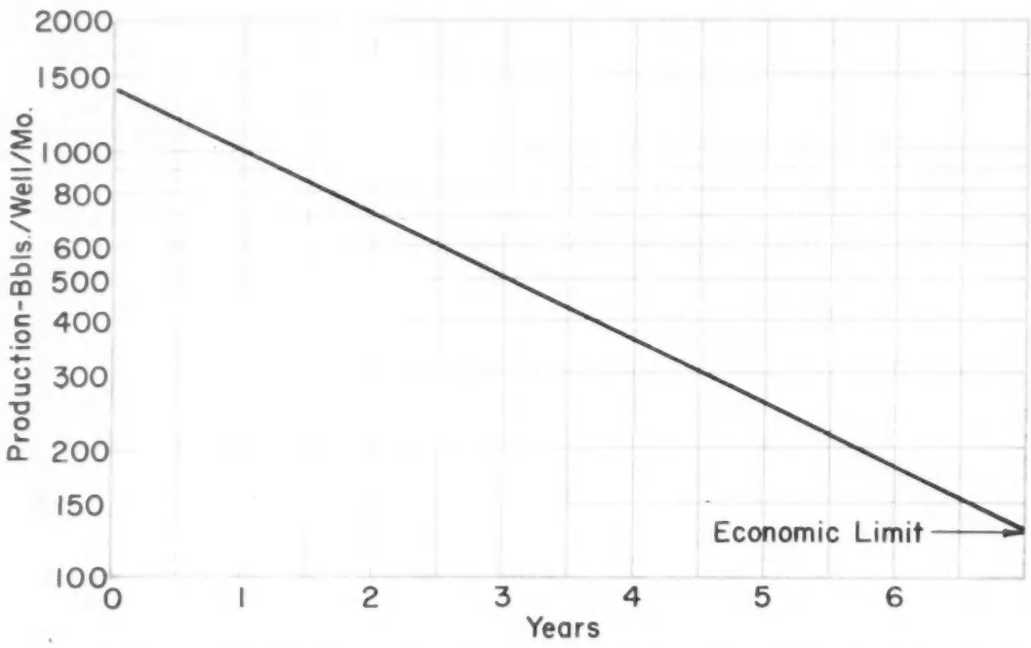

FIGURE 1—Here is a straight line, semi-logarithmic production decline curve. Although properties normally do not exhibit this type of curve, their present worth is computed rapidly. Example 1 shows how to calculate present worth for such a property.

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Computing present worth of oil properties

These new charts quickly and accurately determine value of future production. Developed for monthly accounting, the curves possibly yield more accurate results than techniques on discounting annual production

By Paul B. Crawford, Assistant Director
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Texas Petroleum Research Committee
College Station, Texas

A SERIES of recently developed charts permits engineers to estimate rapidly and accurately the present worth of royalty and working interests from oil properties having various types of production decline curves which may be expressed as a straight line on semi-log paper. All figures have been computed on a monthly basis and may be used for most ranges of interest rates and decline rates found in practice. Also, the graphs may be used to predict future cumulative oil production to the economic limit.

The increasing number of transactions on oil properties requires a fast and accurate method of determining the present worth of future production. Present methods are either slow or if rapid, may be too inaccurate for engineering and financing purposes. The production decline curves of a well, lease or field differ and depend on many factors. For this reason, each property has to have special attention, and few generalizations can be made concerning the prediction of future behavior.

Engineers make various plots of the production decline curve. In a few cases, a plot of the production decline curve on semi-log paper results in a straight line. In many cases, a plot of the production decline curve on log-log paper yields a straight line. In special cases, the production decline curve is a straight line on Cartesian coordinate paper; however, this is rare. In some instances, the usual plots fail to give a straight line, and it is necessary to shift the curve. A plotting technique which results in a straight line for the period of known production is desirable since the shape of the extrapolated portion of the curve and estimation of future production may be less subject to error.

Proration has a significant effect on the production de-

cline curve, and in the early life of the field proration may prevent establishment of the reservoir's natural decline characteristics. In the United States, 204 fields have 57 percent of the oil reserves. The remaining reserves are found in approximately 11,650 fields.[1] Production from all the 204 larger fields probably is restricted by proration; however, many of the 11,650 smaller fields are producing at their maximum rate. It is the wells and leases in these unrestricted fields that develop characteristic production decline curves.

Graphs assist. All production decline curves will not conform to the types treated in this article. However, if the decline curve does conform, these methods can be used. With these facts in mind, graphs have been prepared which enable the engineer to compute rapidly the present worth of future oil production from leases or wells with the following types of production decline curves:

- The production decline curve is a straight line on semi-log graph paper.
- The production decline curve curves upward or downward on semi-log paper and yields a straight line on semi-log paper after addition or subtraction of a constant to the production rate.
- There is a constant production rate for the life of the well or until water breakthrough.

The graphs presented may be used in finding the present worth of the royalty interest, or the present worth of the working interest of a well or lease assuming constant monthly or yearly production costs. The graphs also may be used for predicting future cumulative oil production from the producing properties.

All curves included have been calculated in terms of monthly increments for greater accuracy and because most present day accounting statements are computed monthly. The graphs are accurate for estimating the present worth to within 1 or 2 percent. Frequently, the production decline curve of producing properties gives either a straight line on semi-log paper or a curve concave upward which many times can be straightened by subtracting a constant value from the production rate.

This straightening procedure is necessary before using these graphs for determining either the present worth of future production or future cumulative production. In some water-driven reservoirs, the production rate is constant until water breakthrough. This type of production curve is discussed, and an example is shown for determining present worth of future production in this case.

As the slopes of the decline curves for producing properties differ, depending on the production rate, type expulsive force and many other physical characteristics of the reservoir, so does the appropriate discount rate differ depending on the characteristics of the producing property, the purchaser and lending institution. These facts have been considered, and the graphs may be used for various interest rates and production decline rates.

Once the present worth has been established, it can be discounted substantially for loan purposes, depending on all factors believed to affect the particular investment. For most discount factors, these graphs can be used with sufficient accuracy.

Application. In the past, the engineer has made various types of production rate plots to estimate future oil production with reasonable accuracy. From this estimate of the production rate, discount factors have been applied and net sums have been accumulated to find the present worth of this production, either in barrels of oil or dollars.

In applying the methods presented here for determining the present worth of future production, the first necessary step is to obtain a straight line production decline curve on semi-log graph paper either by plotting the production data directly or by making use of the straightening technique. The straightening technique is illustrated in several examples. The first three examples show the determination of the present worth of the royalty interest for a particular well or lease. The next three examples show the determination of the present worth of the working interest of a well or lease.

These examples show the techniques for calculating present worth for straight line, concave upward and constant rate production decline curves. The examples illustrate the worth of royalty and working interest. Examples are given for determining the predicted cumulative production for three types of decline curves.

ROYALTY INTEREST

Example 1—Production rate is a straight line on semi-log paper. Figure 1 shows a straight-line production decline curve on semi-log paper. It is rare that properties have this type of curve, but their present worth is computed rapidly. The present value of future production from such property depends on the time to the economic limit, the production decline rate, curent interest rate, tax situation, etc. The time to the economic limit is obtained from the date of evaluation of the reservoir. Of course, the production decline curve is an extrapolated

Symbols used throughout example portion of this article . . .

- c = Monthly production costs, dollars.
- f_b = Present worth factor obtained from Figure 2, Note $f_b = f_a \div (R_1 + R_2)$.
- f_c = Present worth factor obtained from Figure 4. "f_c" is the present worth of one dollar or one barrel of oil received each month for "t" months discounted at the indicated interest rate.
- I = Annual interest rate.
- K = Constant *added* to production rate, to obtain a straight line for concave upward curve. Note that the sign will be *minus*, bbls/month.
- P = Net price per barrel of oil produced, dollars.
- P. B. = Profit per barrel of produced oil, dollars/barrel.
- P. W. = Present worth in dollars.
- q_1 = Oil production rate at beginning of period of valuation, bbl/month.
- q_2 = Oil production rate at time, t_2, barrels/month.
- q_o = Oil production rate at time, t_o.
- Q_t = Total or cumulative oil production, barrels.
- R_1 = Interest rate factor obtained from Table insert in Figure 2.
- R_2 = Monthly production decline rate, obtained from Figure 2-A or Figure 2-C.
- R. I. = Royalty interest, (fractional) assumed 1/8 in these examples.
- t = time, in months.
- T = time, in years.
- W. I. = Working interest, (fractional) assumed to be 7/8 in this paper.

curve from the date of evaluation to the economic limit. The date of evaluation is shown as zero time in Figure 1.

The following detailed procedure is given to illustrate techniques developed herein.

a. Given:

(1). Production Decline Curve, Figure 1

(2). Interest Rate = 7 percent

(3). Net Price per Barrel of Oil = $2.50

(4). Royalty Interest = 1/8

(5). Time to Economic Limit = 7 years

b. Required: Present worth of the royalty interest

c. Solution:

The present worth equation for this type production is as follows:

$$P.W. = (q_1)\ (P)\ (f_b)\ (R.I.) \qquad (1)$$

Where

q_1 is 1,400 barrel/month from Figure 1

P is the *net* selling price per barrel of produced oil, $2.50/barrel.

R.I. is the royalty interest, 1/8 in this case

R_1, the *monthly* interest rate *factor*, is found from the Table accompanying Figure 2. At 7 percent interest, the factor is equal to 0.0058501.

Various Values of the Monthly Interest Rate Factor

Nominal Interest Rate Percent	R_1 for Present Value Calculations	Nominal Interest Rate Percent	R_1 for Present Value Calculations	Nominal Interest Rate Percent	R_1 for Present Value Calculations
2	0.0016683	5¼	0.0043843	8½	0.0071076
2¼	0.0018766	5½	0.0045932	8¾	0.0073180
2½	0.0020850	5¾	0.0048031	9	0.0075283
2¾	0.0022944	6	0.0050125	9¼	0.0077380
3	0.0025031	6¼	0.0052216	9½	0.0079484
3¼	0.0027117	6½	0.0054316	9¾	0.0081580
3½	0.0029212	6¾	0.0056407	10	0.0083676
3¾	0.0031298	7	0.0058501	10¼	0.0085783
4	0.0033385	7¼	0.0060601	10½	0.0087881
4¼	0.0035481	7½	0.0062693	10¾	0.0089978
4½	0.0037569	7¾	0.0064786	11	0.0092087
4¾	0.0039656	8	0.0066885	12	0.0100481
5	0.0041751	8¼	0.0068982		

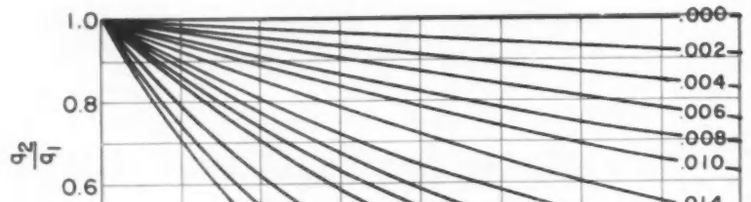
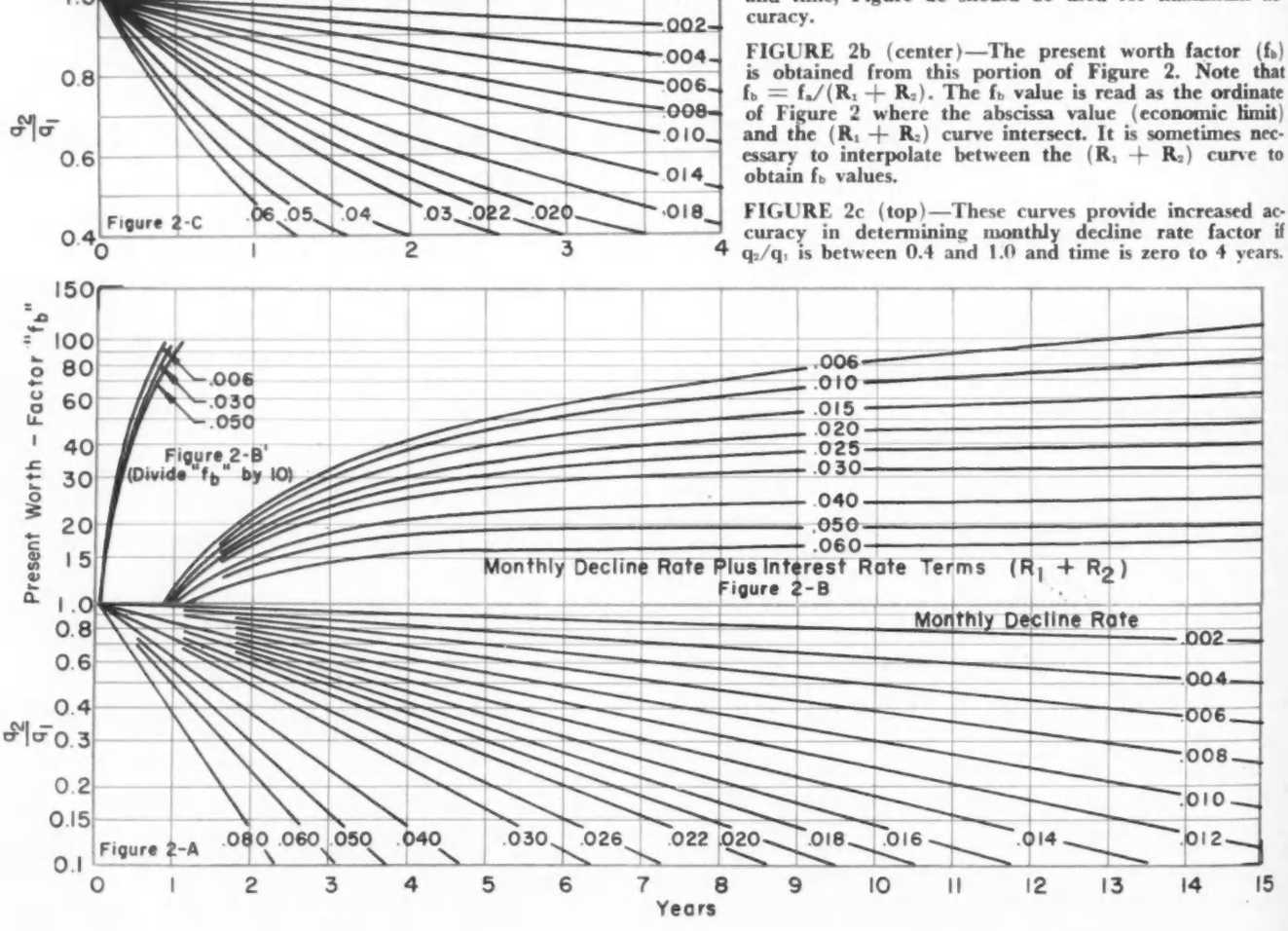


FIGURE 2a (bottom)—Monthly decline factor (R_c) is determined from these curves. Values of q_2/q_1 are used for any time t. For specific values of q_2/q_1 and time, Figure 2c should be used for maximum accuracy.

FIGURE 2b (center)—The present worth factor (f_b) is obtained from this portion of Figure 2. Note that $f_b = f_a/(R_1 + R_2)$. The f_b value is read as the ordinate of Figure 2 where the abscissa value (economic limit) and the $(R_1 + R_2)$ curve intersect. It is sometimes necessary to interpolate between the $(R_1 + R_2)$ curve to obtain f_b values.

FIGURE 2c (top)—These curves provide increased accuracy in determining monthly decline rate factor if q_2/q_1 is between 0.4 and 1.0 and time is zero to 4 years.



R_2 the *monthly* decline rate *factor,* is read from Figure 2-A using a "q_2/q_1" value for any time "t." For this example taking q_1 at zero time and q_2 at 5 years,

$$\frac{q_2}{q_1} = \frac{250}{1400} = 0.1786.$$

From Figure 2-A, using 0.1786 as the ordinate and 5 years as the abscissa, a value of R_2 of 0.0285 is obtained. This is the monthly decline rate. Note: if q_2/q_1 is between 0.4 and 1.0 and the time is zero to 4 years Figure 2-C should be used to obtain maximum accuracy.

f_b is read as the ordinate of Figure 2 where the 7-year abscissa (economic limit) and the $(R_1 + R_2) = 0.0343501$ curve intersect. It is necessary to interpolate between the 0.030 and 0.040 curves for this reading. The value of "f_b" is approximately equal to 27.6 for this example.

The present worth equation becomes:

P. W. = (1400) ($2.50) (27.6) (⅛)

P. W. = $12,075.00

The present worth of this royalty interest by the conventional method was found to be $11,925.18, which is 1.24 percent lower than the graphical method value. The differences in results found in these and other examples range from 1 to 2 percent and probably are due to inaccuracies in reading the graphs, reading the decline rate R_2 or errors in reading the production rate on a monthly basis.

Example 2—Application of a constant production rate until water breakthrough. In prorated water-driven reservoirs, the oil production rate may be approximately constant until water breakthrough, at which time the economic life of the well or lease may be essentially achieved due to the rapid increase in water production. Thus, an estimate of the present worth of future production until water breakthrough can be made and may be fairly representative of the actual worth of the production.

An example of the computations necessary for this type production is given below for the present worth of the royalty interest in a lease:

a. Given:

(1). q_1 = Constant production rate of 300 bbl/month

(2). Interest rate = 7 percent

(3). Net price per barrel of oil = $2.50

(4). Royalty interest = ⅛

(5). Time to breakthrough = 7 years

b. Required: Present worth of the royalty interest

c. Solution:

The present worth of future production for a constant production rate type reservoir is as follows:

$$P.\ W. = (q_1)(P)(f_c)(R.I.) \qquad (2)$$

Where:

q_1 is the constant production rate (equal to 300 barrels per month for this illustration)

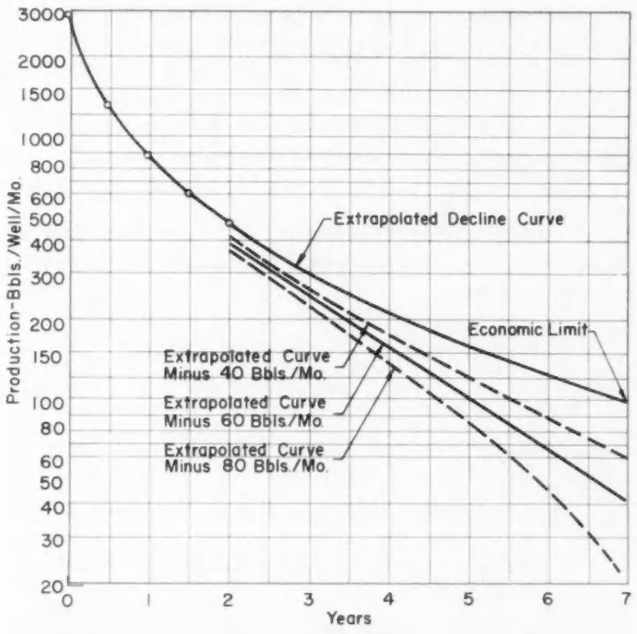


FIGURE 3—Here is an example of a production decline curve which is concave upward on semi-log paper. Various constants have been subtracted from the production rate in order to straighten the curve. It should be noted that the subtraction process must be applied after production has settled. Only the settled portion of the curve was straightened. The subtraction of 60 barrels per month from the production rate straightened the curve satisfactorily. Example 3 shows how to determine the present worth of future production from properties exhibiting this type of decline curve.

P is the net selling price of oil per barrel, $2.50/barrel

f_c is read from Figure 4 at the intercept of the 7-year abscissa and 7 percent interest curve, and equals 67

R.I. = royalty interest = ⅛

Hence:

P. W. = (300) ($2.50) (67) (⅛)

P. W. = $6,281.25

The present worth of the royalty interest using the conventional tabular summation technique was 1.11 percent below this graphical solution value.

Example 3—Application to a concave upward production decline curve. In many instances, the production decline curve is concave upward on semi-log paper. If this is the case, the concave curve can be made a straight line by subtracting a constant from the production rate. However, this process has to be applied after production has settled.

As seen in Figure 3, the initially high production and decline rates have been omitted from the straightening process, and only the settled production part of the curve was straightened. For this decline curve, it was necessary to subtract 60 barrels per month from the production rates to straighten the curve. The subtraction of 40 or 80 barrels per month resulted in a line curving up or down, respectively. The method of determining the present worth of future production from this type production decline data is as follows:

a. Given:

(1). Decline curve shown in Figure 3

(2). Interest Rate = 7 percent

(3). Net price per barrel of oil = $2.50

(4). Royalty interest = 1/8

(5). Time to economic limit = 5 years

b. Required: Present worth of royalty interest

c. Solution:

The equation for calculating the present worth of future production from this type production decline curve is shown as follows:

$$P.W. = \left[(q_1 + K)(f_b) - (K)(f_c)\right](P)(R.I.) \qquad (3)$$

From the decline curve, Figure 3

q_1 is read as 470 barrels per month at zero time (date of valuation).

K, the constant *added* to the production rate straighten the concave curve, is (—) 60 barrels/month for this example, as shown in Figure 3.

P, the net selling price of produced oil, is $2.50/barrel.

R_1 is 0.0058501 for a 7 percent interest rate, from table in Figure 2.

R_2 the monthly decline rate factor, is read from Figure 2-B by using q_2/q_1 for a 5-year period (0 to 5 years) as $\frac{41}{410} = 0.100$. This ordinate intersects the 5-year abscissa of Figure 2-A at a value of $R_2 = 0.0375$.

f_b is found from Figure 2-B at the intercept of the $R_1 + R_2 = 0.04335$ curve and the 5-year abscissa, and is found to be 21.3.

f_c is found from Figure 4 by reading the ordinate value at the point the 5-year abscissa crosses the 7 percent interest rate curve. The value of f_c is found to be approximately 50.0.

$$P.W. = \left[(470 - 60)(21.3) + (60)(50)\right]($2.50)\,1/8$$

$$P.W. = \$3{,}666.56$$

The present worth of this royalty by the conventional summation tabular method was found to be $3,604.66. This error probably is due to errors in reading the production rates, decline rates, etc.

WORKING INTEREST

The following examples are presented to illustrate the computations necessary in finding the present worth of future production of the working interest in a well or lease. The examples are shown for the case of constant monthly production costs and constant profit per barrel of oil produced for the three types of decline curves described previously.

Example 4—Production decline curve is a straight line on semi-log paper. The present worth of the working interest for the decline curve illustrated in Figure 1 for constant production costs is computed by the graphical method as follows:

a. Given:

(1). Production decline curve, Figure 1

(2). Interest Rate = 7 percent

(3). Net Selling Price per barrel = $2.50

(4). Working Interest = 7/8

(5). Time to economic limit = 7 years

b. Required: Present worth of working interest

c. Solution:

The present worth of the working interest by the graphical method is found by using Equation (4).

$$P.W. = (q_1)(P)(f_b)(W.I.) - (c)(f_c) \qquad (4)$$

Where:

q_1 is the monthly production rate at zero time of valuation from Figure 1, 1,400 barrels/month.

P is the net selling price per barrel for the produced oil, and is equal to $2.50 per barrel.

f_b is found in Figure 2-B as in the graphical solution of Example 1, and is equal to 27.6.

W. I. is the working interest of the property, chosen as 7/8.

c = production cost per month for the well or lease, and is equal to $500/month for this illustration.

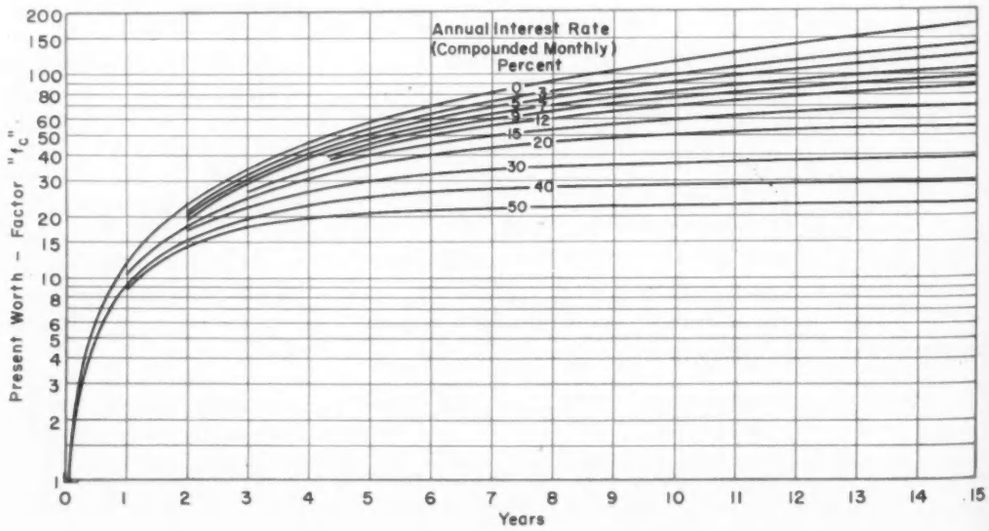


FIGURE 4—The present worth factor (f_c) is obtained from this set of curves. The factor f_c is the present worth of one dollar or one barrel of oil received each month for t months discounted at the indicated interest rate.

f_c is read from Figure 4 at the intersection of the 7-year abscissa and 7 percent curve, and is equal to 66.26.

The present worth then is calculated as:

P. W. = (1400) ($2.50) (27.6) (7/8) — ($500) (66.26)

P. W. = $51,396.36

Example 5—Application to a constant production rate until water breakthrough. The present worth of the working interest for a prorated, water driven reservoir, illustrated in Example 2, is found by performing the following computations:

a. Given:

(1). q_1 = Constant Monthly Production Rate = 300 barrels/month

(2). Interest Rate = 7 percent

(3). Net price per barrel = $2.50

(4). Working Interest = 7/8

(5). Time to breakthrough = 7 years

b. Required: Present Worth of Working Interest

c. Solution:

The present worth equation for this determination is as follows:

$$P.W. = (q_1)(P)(f_c)(W.I.) - (c)(f_c) \quad (5)$$

Where:

q_1, P and W. I. given above

f_c = 66.26 same as found in Example 4

c = $200/month production costs

P. W. = ($300) ($2.50) (66.26) (7/8) — ($200) (66.26)

P. W. = $30,229.70

Example 6—Application when the production decline curve yields a straight line on semi-log paper after the subtraction of a constant from the production rate

a. Given:

(1). Decline Curve, Figure 3

(2). Interest Rate = 7 percent

(3). Net Price per Barrel = $2.50

(4). Working Interest = 7/8

(5). Time to economic limit = 5 years

b. Required: Present Worth of Working Interest

c. Solution:

The equation for determining the present worth of this lease is:

$$P.W. = (W.I.)(P)\left[(q_1 + K)(f_b) - (K)(f_c)\right] - (c)(f_c) \quad (6)$$

Where:

W. I., q_1, K, P, f_b, and f_c are given in Example 3

c = $300/month

The present worth then is calculated as:

P. W. = (7/8) ($2.50) [(470 — 60) (21.3) + (60) (50)] — ($300) (50)

P. W. = $25,665.94 — $15,000.00

P. W. = $10,665.94

Example 7—Prediction of future cumulative oil production from various decline curves. In many instances, it is desirable to predict accurately the future total cumulative production from a well or a lease. The graphs in this article are easily adapted for this purpose. The total oil production is obtained by letting the *interest rate* be *zero*, and the *price* be $1.00/barrel.

1. Application when the production decline curve is a straight line on semi-log paper:

a. Given:

(1). Decline Curve, Figure 1 (Note that the monthly decline rate R_2 was found in Example 1 to be 0.0285.)

(2). Time to economic limit = 7 years

b. Required: Total future cumulative production from the lease.

c. Solution:

$$Q_t = (q_1)(f_b) \quad (7)$$

Where:

Q_t = Total oil produced from time of valuation to time t_2 or economic limit, barrels

q_1 = 1,400 barrels/month

f_b is obtained from Figure 2-B at the intercept of the 7-year abscissa and $(R_1 + R_2) = R_2 = 0.0285$ curve

Q_t = (1400) (32.0) = 44,800 barrels

2. Application to a concave upward curve on semi-log paper:

a. Given:

(1). Decline Curve, Figure 3

(2). Time to economic limit = 5 years

b. Required: Total Future Cumulative Oil Production

c. Solution:

$$Q_t = (q_1 + K)(f_b) - K(t) \quad (8)$$

Where:

Q_t = Total cumulative production in barrels

q_1 = 470 barrels/month (Figure 3)

K = (—) 60 barrels/month

f_b = 24.2 (Figure 2-B intercept of 5-year abscissa and $(R_1 + R_2) = R_2 = 0.0375$)

Q_t = (470 — 60) (24.2) + (60) (60)

Q_t = 9,922 + 3,600 = 13,522 barrels

The production decline curves illustrated here are idealized for ease in explaining the method of determining present worth. Figure 5 shows a type of curve more frequently encountered. That is, the well has been reworked or stimulated and the resultant production rate was changed markedly. In this instance, it is apparent that the engineer has to estimate the future production after only a very short production period following the last stimulation of the well.

Use care in extending curve. In some instances, engineers familiar with all factors believed to affect the production extend the production curve at a constant decline per year. The techniques presented here are well suited for this type of evaluation or application, but caution should be exercised in extending the curve. The pro-

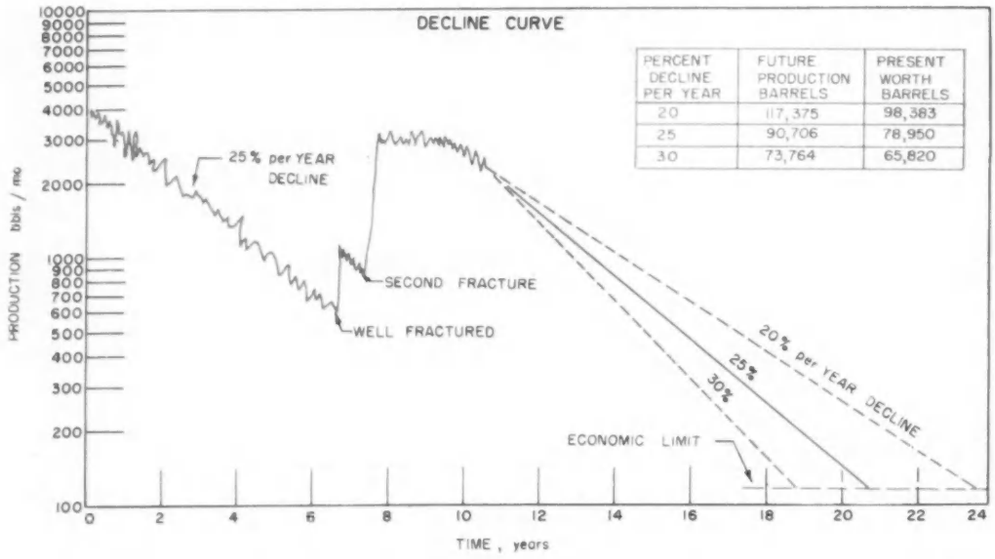


FIGURE 5—This figure emphasizes the importance of the judgment of the engineer in making evaluations. The type of curves shown frequently is found in practice in that the well has recently been worked-over or stimulated and the production rate changed considerably. Future production must be estimated after a comparatively short producing period following the last stimulation work. The decline curve has been extended at constant decline rates of 20, 25 and 30 percent per year. It is apparent that a 10 percent change in the slope of the extended curve can affect present worth values as much as 50 percent.

duction decline curve of Figure 5 has been extended at constant decline rates of 20, 25 and 30 percent per year. The table in Figure 5 shows that the future production represented by these curves is 117,375, 90,706, and 73,764 barrels, respectively. The present worths discounted at 5 percent are 98,383, 78,950 and 65,820 barrels of oil, respectively. It is apparent that a 10 percent change in the slope of the production decline curve may affect the present worth by as much as 50 percent. This emphasizes the importance of the judgment of the engineer in making evaluations.

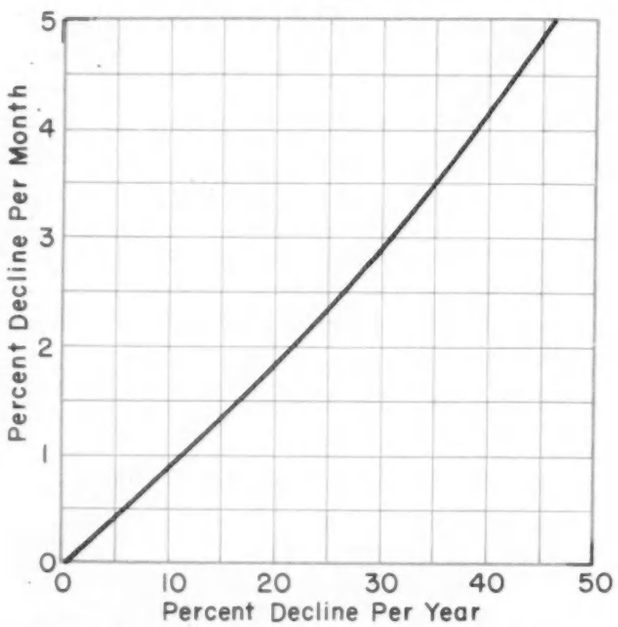


FIGURE 6—The relation between monthly and annual decline rates is shown here. This curve enables engineers to convert from annual decline rates to monthly rates.

Figure 6 shows the relation between monthly decline rate and yearly decline rate. It has been prepared to permit the engineer to convert from annual decline rates to monthly decline rates. The yearly decline rate is always less than 12 times the monthly rate. For example, a yearly decline rate of 30 percent is equivalent to a monthly decline rate of about 2.9 percent.

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REFERENCE

[1] Harold Vance, personal communication.

About the Authors

Crawford

Williams

Dr. Paul B. Crawford received his B.S. degree in chemical engineering from Texas Technological College in 1943. He was employed by the American Cyanamid and Chemical Corporation and worked on the development of synthetic fluid cracking catalysis. He returned to graduate school and received his M.S. and Ph.D. in chemical enginering from The University of Texas. In 1947 he was employed by Magnolia Petroleum Company, field research laboratories, and worked primarily on the underground combustion recovery process, a method whereby oil is produced by the creation and propagation of a burning zone within the oil-bearing rock. He is the inventor of several innovations of the process. In 1952 he was employed as assistant director of the Texas Petroleum Research Committee, Texas A. & M. College Division. He is a member of the graduate faculty and is a consulting engineer.

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Prospects vary widely in northern South America

Venezuelan potential enormous; vast Colombian Basins little developed; Ecuador seeks new oil provinces

This is the fourth and concluding article of an exclusive WORLD OIL series on South American prospects. The first, illustrated with a series of maps of the continent, traced movements of ancient seas and showed resulting sedimentary basins. The second described oil prospects in Argentina, Uruguay, Paraguay, and Chile, and the third dealt with Brazil, Bolivia, and Peru. This article describes oil prospects in Ecuador, Colombia and Venezuela.

By Carl A. Moore, Chairman, School of Geological Engineering, University of Oklahoma

WHILE PRODUCTION IN ECUADOR has been limited to the Santa Elena Peninsula and limited exploration elsewhere has failed to locate a second oil province, several basins in Colombia have been proved oil-bearing and vast new areas remain to be tested. In Venezuela, major reserves continue to be found in both western and eastern basins; and possibilities remain in the Barinas-Apure Basin, the most recent to be opened to commercial production.

ECUADOR

CURRENT PRODUCTION in Ecuador is limited to the coastal area in the open marginal basin west of the mountains. Oil is produced from middle and upper Eocene, and Cretaceous beds, similar to western Peru.

Recorded oil production in Ecuador dates from 1917. Cumulative production is more than 70 million barrels. Recoverable reserves are estimated at about 25 million barrels.

Production has come from the Santa Elena Peninsula, west of Guayaquil. Most of the recent drilling activity has been in the development and extension of the proved areas. Best production has been found in faulted zones. The Ancon field, discovered in 1921, produces from depths of 400 to 5,000 feet. Daily production at Ancon is about 6,300 barrels, with a cumulative total of 59,676,610 barrels as of midyear 1959. Gravity is 37° API. Other fields on the Santa Elena Peninsula produce similar oils from a variety of depths.

Future. Through additional development, formation fracturing, and secondary recovery programs, Ecuador's production is being maintained. Recent exploratory efforts in the Manta Concession may open up a new area of development for coastal Ecuador. The Esmeraldas area farther north may be explored.

The Esmeraldas area lies at the south end of a series of deep sinks in the Bolivar Geosyncline, which extends along the western coastal area of Colombia into northwestern Ecuador. Objectives in this area, however, may be quite deep and activity may be postponed for a number of years.

Eastern Ecuador. This region is a northward extension of the Montaña (Oriente) of Peru. Lower Cretaceous sandstones rest on basement and on older sedimentary rocks. These are in turn covered by marine middle Cretaceous sediments. This same stratigraphic sequence extends from eastern Colombia southward across Ecuador and almost across Peru.

Structures should be encountered near the mountains. There are possibilities of stratigraphic traps on the eastern side of the basin. The eastward limit of the basin is covered by the flood plain alluvium of the Amazon River and its tributaries, and the subsurface geology is very little known due to the lack of wells penetrating the upper Tertiary and Quaternary mantle.

Oil possibilities will be limited to the lower and middle Cretaceous rocks, since the upper Cretaceous and Tertiary rocks are non-marine. (Figure 2)

COLOMBIA

COLOMBIA RANKS SECOND only to Venezuela as a petroleum producing country in South America. Since the beginning of commercial production in 1921 through 1958, Colombia produced a cumulative total of 840 million barrels of oil. This is less than one percent of the world's total production, but it is almost 6 percent of the total for South America. Reserves are conservatively estimated at 650 million barrels.

The principal older oil producing areas of Colombia

FIGURE 1—Generalized Sedimentary Section, Southwestern Ecuador

Pleistocene		Tablazo sandstones and shelly limestones. Alluvium and gravels.
Pliocene		Puná sandstones.
Miocene	Middle	Progreso clays and sandstones.
	Lower	Subibaja clays and siltstones.
Oligocene		Dos Bocas clays and Cardon sandstone.
Eocene	Upper	Zapotal sandstone Ancón Point sandstone Seca clays Socorro clays and sandstones*
	Middle	Clay Pebble Beds
	Lower	Azucar Sandstones*
Cretaceous	Upper	Guayaquil (Santa Elena) clays & argillites*, with cherts and tuffs.
	Middle	Callo extrusives
Jurassic?		Piñon Volcanics

* Chief oil producing horizons.

THE PERFECT COMBINATION

For Protecting Low Pressure Producing Zones

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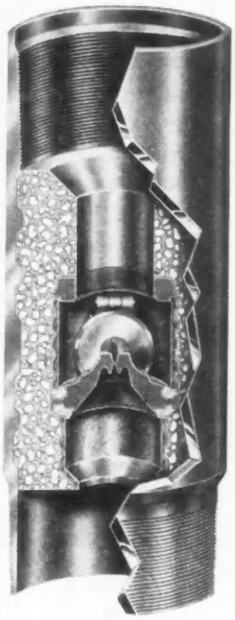
A LARKIN CEMENTROL GUIDE SHOE



Filrite Float Collar
Fig. 451

FILRITE EQUIPMENT was designed to allow automatic filling of the casing while it is being run and to eliminate pressure surges which might break down weaker formations.

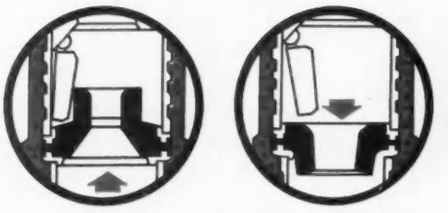
CEMENTROL EQUIPMENT was originated by Larkin for the purpose of protecting exposed producing formations against contamination by cement. Cementrol effectiveness has been proved in thousands upon thousands of wells over a period of fifteen years.

In combination, Filrite and Cementrol Equipment will provide maximum protection when casing is cemented above a producing zone.

Filrite Equipment contains a resilient diaphragm valve which prevents entrance of well fluid into the casing until several joints have been run. When fluid pressure from below overcomes the inherent resistance of the valve to open, the valve then opens and allows partial fill of the casing without overflow. This type of fill-up is continuous until casing is landed.

The Cementrol Guide Shoe serves as a guide until casing is landed. A bridging ball is then dropped and by pump pressure from the surface the Cementrol packing element is expanded against the wall of the hole and no cement can contact the producing zone.

For additional details on Filrite and Cementrol please refer to your Larkin catalog—or call your nearby Larkin representative.



A

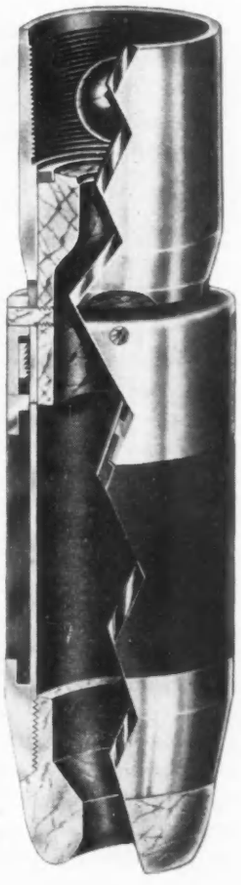
Circle A, a view 90° from that of the large illustration, shows the Filrite valve in running-in position. The resilient diaphragm valve remains closed until the differential fluid pressure across it overcomes its inherent resistance to open.

B

Circle B shows the rubber diaphragm inverted by pump pressure as the well is being cemented. Filrite is full opening and will allow passage of a bridging ball to actuate other equipment which might be installed on the casing beneath a Filrite Collar.

C

Circle C shows the spring-loaded flapper valve in closed position after being released by inversion of the diaphragm. The flapper valve in the Larkin Filrite equipment is very strong and has no depth limitations.



Cementrol Guide Shoe
Fig. 227

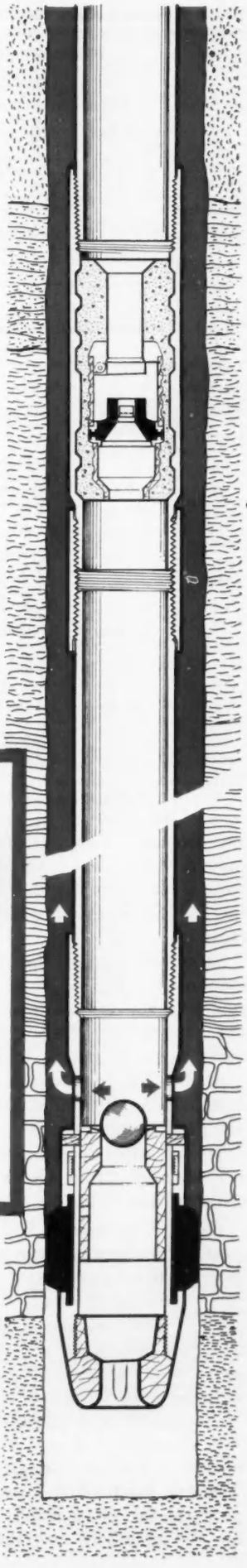


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FIGURE 2—Generalized Sedimentary Section, Eastern Ecuador

Tertiary		Non-marine shales and sandstones; volcanics
Cretaceous	Upper	Tena red beds
	Middle	Napo limestone and shale
	Lower	Hollin sandstone
Jurassic		Chapiza red sandstone, shale, some evaporites; includes the Misahualli tuffs Santiago limestone
Carboniferous		Macuma limestone, hard sandstone
Early Paleozoic		Pumbuiza and Margajitas formations
Precambrian		Basement rocks

FIGURE 3—Generalized Sedimentary Section, Middle Magdalena Valley, Colombia

Quaternary		Magdalena non-marine clays, sandstones
Pliocene		Mesa sandstone and shale
Miocene		Real non-marine series
Oligocene		Colorado series La Cira shale, fossil zone Petoles shale Guamite pebbly sandstone Taza sandstone Mugrosa sandstone, ** fossiliferous
Eocene		Chorro series** Esmeraldas sandstone La Paz pebbly sandstone Toro shale and limestone Lisama shale; coal beds
Cretaceous	Upper	Umir shale; beds sandstone
	Middle	Palmira limestones and chert Tablazo shale and limestone
	Lower	La Paja shale Rosa Blanca limestone
Jurassic?		Giron sandstone; minor shale
Precambrian		Basement rocks

** Chief oil producing horizons.

are located in two distinct petroliferous basins: the middle Magdalena River Basin, with the De Mares Concession having the greatest cumulative production; and the Barco Concession which lies east of the Andes Mountains.

Production from the De Mares Concession has amounted to over 476 million barrels of oil, from sandstones in the Eocene and Oligocene (the Mugrosa, and the Chorro and Colorado series—Figure 3). Of these, the Chorro yields the bulk of Colombia's oil, primarily from the Infantas and La Cira anticlines. These intermontane deposits of clays, sandstones and pebble beds are predominantly non-marine, with a few marine beds deposited when the seas occupied the Magdalena Valley.

Production from De Mares averaged 28,381 barrels daily in May 1959.

Barco Concession. East of the Cordillera Oriental (Andes Mountains), lying within the Maracaibo (Zulia) Basin is the Barco Concession. First recorded production was in 1933, although Royal Dutch Shell drilled two shallow wells as early as 1914 on the Rio de Oro structure just across the boundary in Venezuela for small production. This original production has been followed by production from five anticlinal fields.

Total cumulative production from the Barco Concession through 1956 was almost 122 million barrels, from middle Cretaceous limestones and standstones, and basal Tertiary sandstones. Surface geology, plane table mapping, aerial photographs and geophysics were utilized for the complete structural analysis of the concession. Crude oil production in May 1959 was 25,562 barrels daily. Future possibilities are fair, with extensions and secondary recovery programs expected to provide additional oil. (Figure 4)

In addition, the Palagua-Velasquez vicinity in the upper Magdalena Valley, south of the De Mares Concession, is productive. Texas Petroleum Company is moving the crude by pipe line. During 1956 the company produced almost 100,000 barrels from Eocene and Oligocene sandstones at Velasquez. Production from this field was 29,500 barrels daily in May 1959.

In the lower Magdalena Valley, north of El Banco, Difícil field produces from Tertiary rocks on an anticlinal structure.

The Cicuco field, discovered in 1956 by Mobil Oil Company, is becoming increasingly more important. It is believed capable of producing as much as 50,000 barrels of crude daily. Probable reserves estimates as high as 500 million barrels have been reported at Cicuco.

Future. The future of oil production in Colombia is bright. A good petroleum law and known production encourage exploration and development.

In addition to the present producing areas, a number of prospective areas may be expected to produce significant quanities of petroleum.

North coastal area. (Figure 5). This is perhaps the most favorable area for exploration. It constitutes an open marginal type of basin, which is favorable for the accumulation of major amounts of petroleum.

Marine Tertiary and (possibly) unknown Cretaceous rocks underlie the coastal area. Depths to test all the Tertiary, and any Cretaceous beds present will depend on basin position and on the presence of structures.

The Floresanto anticline was tested several years ago and yielded a small amount of oil in marine Oligocene sediments. The test was later abandoned. This concession, which lies along the Sinu River about 100 miles south of Cartagena, has been reactivated. The previously-found shallow production, at about 1,500 feet was to be reopened and an attempt will be made to develop deeper production at 8,000 to 10,000 feet.

Multiple lensing sandstones and up-dip wedges of marine Tertiary rocks should provide proper source and reservoir rocks in this area. El Difícil and Cicuco fields indicate that these favorable conditions exist. Production of gas has been reported a few miles south of Covenas.

As in other coastal areas, offshore possibilities become important for full consideration of the area. Strata that are productive on land should be thicker and contain more sandstones offshore.

Western Coastal Area. This is an open marginal type basin with the thickest sediments being located along the coast, or just inland from the present coast line. The entire known geologic section here is marine Tertiary, with the Cretaceous rocks either being absent, or their nature unknown. Paleozoic rocks may underlie much of this area, but they will be at excessive depths.

There are five deeps, or sinks, along this coastal area, extending from northwestern Colombia into northern Ecuador. Marine Tertiary sediments should thicken lo-

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cally in these deeps, and stratigraphic conditions should be favorable for accumulation of petroleum.

Perhaps the chief deterrent in this area is the excessive depths to test the entire Tertiary section. From 20,000 to 30,000 feet of marine Tertiary sediment is present.

Geologic history is of transgressive marine conditions from the Eocene to the Miocene. Some of these marine sediments reached as far east as the Cauca River, across the western Cordillera. Succeeding Andean movements have isolated these lower Tertiary sediments along the Cauca River. Production has been found in the Eocene in the two southernmost deeps, in Ecuador.

As the Andes Mountains received successive uplifts, the depositional history of the Miocene to Recent has been one of regressive sedimentation. There was considerable igneous activity in this area during the Pliocene.

Offshore possibilities along the western coastal area are unevaluated.

Llanos-Apuré Basin (Cordillera Oriental). This basin extends from the Andes eastward to the Guiana shield. It is an asymmetrical type basin with the deepest part on the west, becoming shallow toward the east. Structural traps are anticipated on the west, with stratigraphic traps toward the east.

Llanos-Apuré occupies a sink within the major asymmetrical trough located east of the Andes Mountains. It is bounded on the south by Cerro Macarena, where older Paleozoic rocks and pre-Cambrian basement rocks are either on, or are very near, the surface; and extends northeastward into the Barinas area of Venezuela.

Marine Paleozoic, non-marine Jurassic, marine Cretaceous, and non-marine Tertiary rocks are found in the basin. The eastward limit of the pre-Tertiary and older Tertiary rocks is not known. Non-marine Jurassic beds may be present only near the mountains.

The entire area of the basin can be listed as favorable for exploration. Structures will be found in the western part at considerable depths, however, possibly below economic drilling depths. Stratigraphic traps may be anticipated in the Cretaceous rocks along the middle and eastern parts of the basin at moderate depths.

Caqueta Basin. This is a twin to the Llanos-Apure basin. It lies east of Florencia and south of Cerro Macarena. Surface rocks are upper Tertiary to Recent deposits of the tributaries of the Amazon River. Geophysics related to all subsurface geological data will be necessary to explore this basin.

The lower Paleozoic, upper Paleozoic, Cretaceous, and lower Tertiary rocks may be marine. The upper Tertiary is non-marine.

VENEZUELA

TRULY A GIANT AMONG OIL PRODUCING NATIONS, Venezuela has produced more than 12 billion barrels of oil, about 11 percent of the world's total production. During the record year 1957, Venezuela produced 1,040,625,000 barrels, or 16.21 percent of the world total. Reserves are estimated at 17 billion barrels, and are being increased each year.

First recorded production in Venezuela was in 1917, although two shallow wells southwest of Lake Maracaibo produced some oil as early as 1914. Prior to this, the great pitch deposits of Lake Maracaibo were known.

Oil is produced from Cretaceous and Tertiary rocks. Tertiary reservoirs are by far the most important from the standpoint of production and reserves. Some new oil is being sought and proved in marine Cretaceous strata in western Venezuela.

Eastern Venezuela. The Orinoco (Eastern Venezuela) Basin is a type asymmetrical basin as proposed by Weeks (1952). The coastal ranges along the northern coast make up the borderland. Immediately to the south is the trough area where production has been obtained from structural traps.

Stratigraphic accumulations are found across much of this basin, especially along the southern margin, where the sediments thin onto the Guiana shield. The basin extends eastward across the Gulf of Paria to Trinidad.

FIGURE 4—Generalized Sedimentary Section, Barco Concession Area, Colombia

Pliocene		Necesidad sandstone
Miocene		Guayabo shales and sandstones
Oligocene		Leon shale Carbonera shale, beds sandstone; lignite beds
Eocene		Mirador sandstone Los Cuervos shales and sandstone* Barco sandstone*
Cretaceous	Upper	Catatumbo shales and sandstone* Mito Juan shale* Colon shale La Luna limestone*
	Lower	Cogollo limestone* Uribante sandstone and shale*
Precambrian		Basement rocks

* Chief oil producing horizons.

FIGURE 5—Generalized Sedimentary Section, North Coastal Area, Colombia

Pliocene		Coarse sandstones and clays
Miocene	Upper	Galapa-La Popa sandstone
	Middle	Tubara sandstone and shale
	Lower	Las Perdices sandstone
Oligocene		San Juan sandstone and shale
Eocene	Upper	El Carmen red sandstone and shales, few beds limestone

FIGURE 6—Generalized Sedimentary Section, Rio Sinu Basin

Pliocene		Shales, mostly sandy
Miocene	Middle	Sandstone and shale
	Lower	Paujuil sandstone and shale
Oligocene	Upper	Floresanto sandstone*
	Middle	Charrura sandstone
Cretaceous		Limestones

* Oil producing horizon.

FIGURE 7—Generalized Sedimentary Section, Llanos-Apure Basin, Colombia

Tertiary		Thick continental sediments Gualanday Guaduas shales; minor sandstones
Cretaceous	Upper	Guadalupe sandstone; minor shales
	Middle	Villeta limestone and shale; locally sandy
Jurassic?		Giron sandstone
Precambrian		Basement rocks

FIGURE 8—Generalized Sedimentary Section, Eastern Venezuela

Pleistocene		Mesa clays, shales, sandstones
Pliocene		Quiriquire sandstone* Los Piedras
Miocene Oligocene		Santa Ines group Freites* Oficina*
Eocene		Merecure group Penquito
Paleocene		Santa Anita group Caratas Vidono
Cretaceous	Upper	Guayuta group San Antonio Querecual
	Lower	Sucre group = Temblador* Chimana El Cantil Barranquin
Jurassic? Triassic?		Carrizal quartzitic sandstone Hato Viejo

* Chief oil producing horizons.

It appears to be limited on the west by a cross-basin high at El Baul, where Paleozoic rocks are exposed. This ridge of older rocks is believed to connect onto the Guiana shield. Hence, it effectively separates the Orinoco Basin of eastern Venezuela from the Barinas-Apuré Basin of southwestern Venezuela.

Barinas-Apuré Basin. Proceeding westward from El Baul, the Apuré Basin exhibits the same borderland and foreland relations as are found in the Orinoco Basin. The Barinas area in the Apuré Basin is the currently important oil-productive area. It lies near the foot of the high Andes Mountains. Structures produce significant quantities of 25° API gravity oil. Completion of the pipe line to Puerto Cabello has enhanced development of this vast area. (Figure 9)

The Barinas area contains marine Paleozoic, Cretaceous, and lower Tertiary sediments. Lower Paleozoics may be metamorphosed, but the upper Paleozoics may be considered favorable for oil. Marine Cretaceous and Eocene rocks are the oil pay horizons in the Barinas area. These will continue to be the chief objectives for drilling. Upper Tertiary beds are non-marine.

Future developments will include the location and testing of anticlinal structures near the mountains, and the localizing of stratigraphic accumulations on the southeastern margin of the basin. The limiting factors here will be the onlapping extent of the marine Cretaceous and Eocene sediments onto the Guina shield.

Maracaibo (Zulia) Basin. About 70 percent of Venezuela's oil production is from fields in the Maracaibo Basin. Originally the Bolivar Coastal fields, lying along the northeast edge of Lake Maracaibo, were considered to be a series of individual fields. Development has indicated them to be related.

West and southwest of Lake Maracaibo, oil is produced from Cretaceous limestones and sandstones. Practically all the sediments deposited in the Maracaibo Basin area are marine.

Lower Paleozoic rocks have probably been metamorphosed. Upper Paleozoics may be considered as possible source rocks. West of Lake Maracaibo, deeper drilling is proving oil in Cretaceous beds beneath present Tertiary production.

Chief production and reserves in the Maracaibo basin

FIGURE 9—Generalized Sedimentary Section, Barinas-Apuré Basin, Venezuela

Recent		Llanos clays, sands and gravels
Pleistocene		Guanapa boulder conglomerates
Miocene		Rio Yuca non-marine clays, sandstones
Oligocene		Parangula fluvial deposits
Eocene	Upper	Mene Grande sandstones, dark shales Pauji marine shales Caus limestone; hard sandstone
	Middle	Escuque sandstone, thin shales
Cretaceous	Upper	Colon shale, few sandstones and limestones La Luna limestone*
	Lower	Cogollo limestone, sandy at base*
Jurassic?		La Quinta red beds
Permo-Carboniferous		Palmarito shale and limestone
Ordovician?		Mucuchachi slates, phyllites
Precambrian		Granites

* Chief oil producing horizons

FIGURE 10—Generalized Sedimentary Section, Zulia State (Lake Maracaibo and Vicinity), Venezuela

Pleistocene		El Milagro	
Pliocene		Cerro Viga	
Miocene	Middle	Isnotu sandstone* La Puerta sandstone Lagunillas sandstone*	
	Lower	La Rosa sandstone*	
Oligocene	Middle	Icotea sandstones*	
Eocene	Upper	Ambrosio-Mene Grande sandstone* Las Flores-Pauji sandstone* Potreritos sandstone* Misoa sandstone*	
	Middle	Trujillo sandstone*	
Paleocene		Guasare sandstone*	
Cretaceous	Upper	Mito Juan shale* Colon shale*	
	Middle	La Luna limestone*	
		Capacho limestone* Aguardiente sandstone* Apon limestone*	Cogollo*
	Lower	Rio Negro sandstones	
Triassic		La Quinta red beds	
Permian		Palmarito limestone and shale	
Devonian		Momboy shales, sandstones	
Ordovician		Mucuchachi slates	
Precambrian		Iglesias and Igneous	

* Chief oil producing horizons.

are found in Tertiary rocks, with the lower Tertiary reservoirs providing a steadily increasing production.

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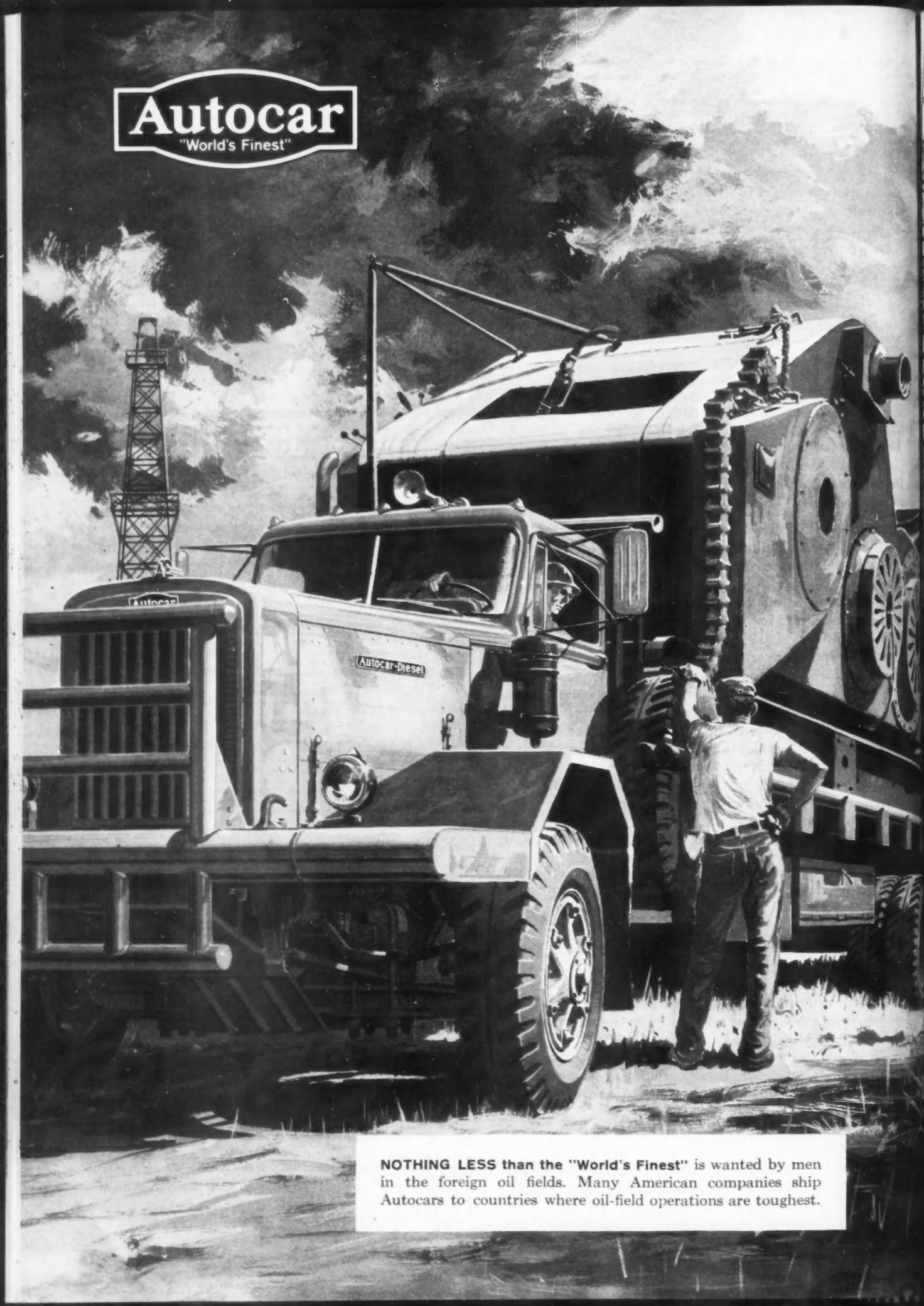

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PART 2

How new additives improve deep well cementing

Successful operations resulted from close cooperation between laboratory, field and service personnel

By J. O. Woodson, Engineer
Phillips Petroleum Company

and **C. L. Fulton,** Engineer
Halliburton Oil Well Cementing Company, Midland, Texas

THE DRILLING of Phillips Petroleum Company's three deep tests; University EE-1, Harral A-1 and Montgomery A-1, were all progressing simultaneously. The cementing operations, primary and secondary, were also taking place at the same time. Consequently, in view of the numerous cementing operations, only the most interesting ones will be discussed in this article. Many of the cementing jobs performed on these wells required the checking and re-checking of thickening times of the recommended slurry to insure its successful placement behind the pipe. All slurries used in these operations were formulated and tested in Phillips Petroleum Company's Technical Services Division Laboratory in Bartlesville, Oklahoma. On the more critical cement jobs, these tests were re-run under the same conditions at the Halliburton Oil Well Cementing Company's laboratories in Odessa, Texas. All tests were made under standard API specifications for testing oilwell cements. Tests at both laboratories were made with identical testing equipment which can simulate actual well conditions as far as temperatures and pressures are concerned. When the results of these tests did not agree, each laboratory was furnished actual samples of water, cement, and additives that would be used. The tests were then re-run until results were verified. In testing materials for some of the deeper cement jobs, it was necessary to change the formulation of the cement blend several times before a slurry having the desired characteristics for existing well conditions was obtained.

It is considered advisable to pretest the cement blend which will be used in any cementing operation where bottom-hole temperatures are expected to be 260° F or above. A sample of the cement to be used on the job should be submitted for test, and this particular shipment of cement for use on this job if thickening-time tests are satisfactory. Actual samples of the additives and mixing water to be used should also be submitted for the laboratory tests. It has been observed that different brands of cement, and even separate lots or shipments of the same brand, may be inconsistent in their behavior at extremely high temperatures. This is not generally cause for concern as long as the aforementioned precautions are taken and these peculiarities are known.

The performance of both crews and equipment during the various cementing jobs performed on the Pecos County wells left nothing to be desired. The operations on each job were more or less routine. In order for deep-well cementing operations to appear routine, coordination among the personnel of the service company, drilling contractor, and operator is required. Advanced planning of the job procedure is necessary, and proper supervision is required to assure that the planned procedure is carried out. The location of each equipment item must be clearly identified and its function understood by the men on the job. This is also true for mud lines, and tanks. This can be more fully appreciated by the fact that some 48 separate service units were required to cement the 9⅝-inch casing in the Montgomery A-1.

Harral A-1. Data pertaining to all casing strings set and cemented in the Harral A-1 well are shown in Figure 1 (Part 1 WORLD OIL, November 1959). Routine cementing practices were used to set 85 feet of 26-inch casing to 36-inch hole and 1,560 feet of 20-inch casing in 24-inch hole. A 12¼-inch hole was then drilled to 10,529 feet where a string of 9⅝-inch casing was set. The 20-inch surface casing had been set to allow for the possible necessity of running 13⅜-inch intermediate casing on this wildcat well. The results of further drilling had proved this tentative casing string would not be required. At the time 9⅝-inch casing was set, the drilling-mud weight was 10.4 ppg. Inasmuch as it was desired to place cement behind the entire casing string and some danger of lost circulation was known to exist, a 10.5 ppg cement slurry was used. The blend consisted of 1,500 sacks of regular portland cement with 84,600 pounds of diatomaceous earth, which is equivalent to 60 percent by weight of the portland cement. When mixed, this blend produced approximately 8,250 cubic feet of 10.5 ppg cement slurry. This lightweight slurry was followed with 300 sacks of slow-set cement for additional strength around the bottom joints of the casing. The cement was displaced with 780 barrels of mud with a maximum displacement pressure of 800 psi. Although circulation was lost during the last 30 barrels of displacement, contaminated cement was circulated and hard cement was found 50 feet from the surface.

An 8½-inch hole was drilled to 15,863 feet where it became necessary

New cement additives

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to set a protective string of 7⅝-inch casing. This string of casing was required because the Harral A-1 had suddenly started behaving like a misplaced Gulf Coast well. From the condition of lightweight mud and cement requirements at the 9⅝-inch casing point, increased mud weights were necessary as drilling progressed. A blowout occurred at 14,589 feet which required 18.2 ppg mud to bring under control. Further drilling to the 7⅝-inch casing point required 17.5 ppg which was normally gas cut. During this period there was a delicate balance between the mud weight required to contain the formation and that weight which would break down the formation. In fact, it is believed there was an overlap, in that certain zones were breaking down at the same time others were unloading into the well bore. The 7⅝-inch casing was set to contain the high-pressure gas zones which were encountered and to allow the mud weight to be decreased to combat the lost circulation problem.

The estimated temperature at 16,000 feet in the Harral A-1 was similar to that of the average Gulf Coast well. This temperature was 280° F at 16,000 feet extrapolated from logged temperatures at shallower depths. This logged temperature would correspond to a circulating temperature of 244° F and a bottom-hole static temperature of 320° F. The cement blend recommended for this string of casing was slow-set cement with 60 pounds of barite per sack and 0.5 percent CMHEC slurried to 17.5 ppg. Laboratory tests showed this slurry to have a thickening time in excess of 4 hours and a 24-hour compressive strength greater than 1,500 psi. Although 40 pounds of barite per sack of cement would normally be recommended to obtain a 17.5 ppg slurry, the exact density requirements for this job were not known and the slurry containing the larger amount of barite could be controlled over a wider range of densities without causing separation of the solid particles from the slurry. The 7⅝-inch casing was set at 15,819 feet and cemented with the recommended cement blend. Only partial returns were obtained during circulation after landing the casing and while mixing and displacing the cement. However, a temperature survey located the top of the cement at 9,905 feet inside the 9⅝-inch casing.

The Harral A-1 was bottomed at 19,020 feet. The logged temperature at total depth was 296° F, which corresponds to a circulating temperature of 260° F, and a static temperature of 328° F. A full string of 5½-inch casing was set to total depth and cemented with 400 sacks of slow-set cement with 10 percent diatomaceous earth and 1 percent CMHEC slurried to a 13.6 ppg. The mud weight at this time was 13.3 ppg. This was the only cement job out of the 14 primary cement jobs performed on the three wells which required remedial squeezing. Although the top of the cement outside the 5½-inch casing was located at 12,040 feet by temperature survey, pressure developed in the annulus and a small gas flow indicated that channeling of the cement had occurred. The small clearance between the 5½-inch casing and 6⅝-inch open hole over a 3,200 feet interval is believed to be the primary

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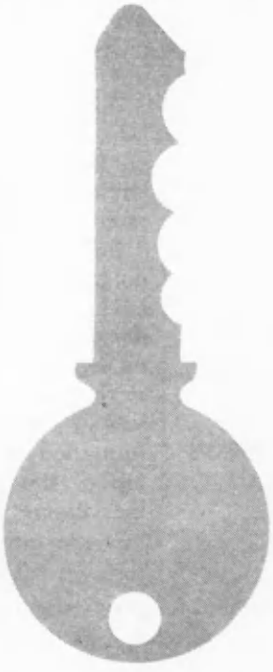

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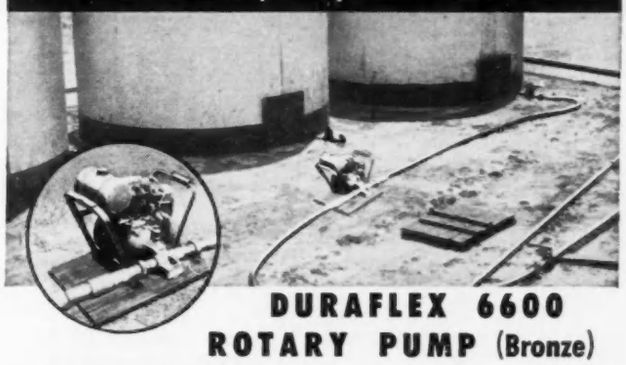

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New cement additives

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cause of this cementing failure. Remedial squeezes in three separate intervals were performed before production tests were begun in the well. A low-water-loss cement was used on each job. Each squeeze job was performed through a drillable retainer and was successful on the first attempt. Surface connections and cement discharge lines were tested to 13,000 pounds before each job. In each case, the desired squeeze pressure of 8,000 psi was obtained at the surface and the excess cement reversed out without difficulty.

Additional cement squeeze jobs and plug-backs were performed during the testing and completion of the Harral A-1. A summary of these jobs is shown in Table 3.

The University EE-1, located approximately 10 miles east of Fort Stockton, Texas, and 11 miles northwest of the Harral A-1, was drilled to the record depth of 25,340 feet. During the drilling and completion of this well, four strings of casing and one liner were set and cemented. Data pertaining to the cement jobs are shown in Figure 1, Part 1, November, WORLD OIL.

The surface string consisted of 1,480 feet of 20-inch casing run in 24-inch hole. The casing was cemented with 2,000 sacks of regular portland cement with 4 percent bentonite and followed with 200 sacks of portland cement with no additives. Cement was circulated to the surface. A 17¼-inch hole was then drilled to 6,020 feet where a string of 13⅜-inch casing was set. This casing string was cemented with 1,685 sacks of regular portland cement with 40 percent diatomaceous earth and 4 percent calcium chloride mixed to 10.9 ppg. The lightweight slurry was followed with 200 sacks of regular portland cement slurried to 15.5 ppg. Circulation was lost when displacement of the cement was started after releasing the top plug, and no returns were observed throughout the remainder of the job. The cement was displaced with a maximum pressure of 500 psi, and the top of the cement outside the 13⅜-inch casing was located at 3,895 feet by temperature survey. Prior to running casing, lost returns had been experienced at approximately 6,000 feet with 9.8 ppg mud while reaming the hole at this depth.

Drilling was continued in the 12¼-inch hole to a depth of 10,996 feet where an intermediate string of 9⅝-inch casing was set. While running this casing, the floating equipment, consisting of two differential fill collars, plugged and circulation could not be established after the casing was landed. The casing was then perforated from 10,888 to 10,890 feet with 8 holes and cemented through these holes with 950 sacks of regular portland cement with 40 percent diatomaceous earth mixed to 10.8 ppg, followed with 300 sacks of neat slow-set cement. Approximately 300 cubic feet of cement slurry was lost to the formation during displacement. The top of the cement outside the 9⅝-inch casing was located at 8,130 feet by temperature survey. As this cement top was only a few feet above a zone of interest for future production tests, it was desired to re-cement at this point. The casing was perforated from 8,088 feet to 8,090 feet with 8 holes, and attempts were made to establish circulation back to the surface. Circulation could not be established, and

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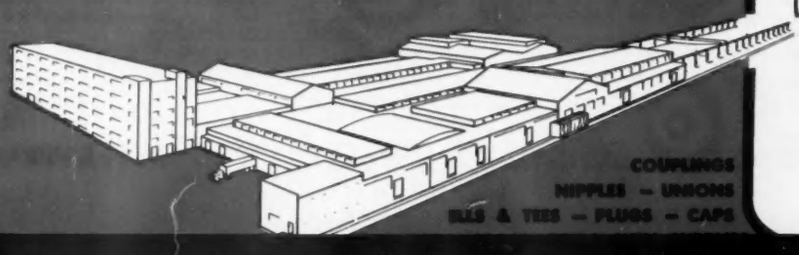

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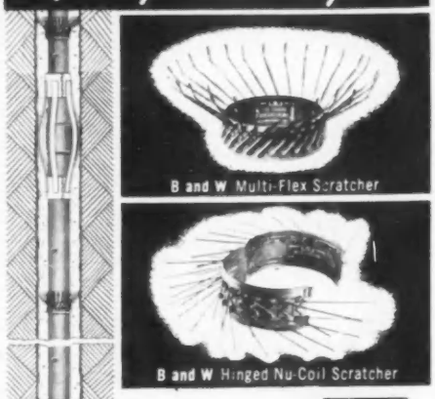

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New cement additives

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the perforations were squeezed with 200 sacks of slow-set cement mixed with water containing radioactive material. A gamma-ray log located radioactive cement from 8,065 to 8,127 feet after the cement in the casing was drilled out and the perforations tested. The floating equipment was then drilled out, and a bridge plug was set a few feet below the bottom of the 9⅝-inch casing. Before running 9⅝-inch casing, an 8½-inch reduced hole had been drilled to 11,556 feet. Circulation was established around the bottom three uncemented lengths of casing by setting a retrievable packer below the perforations 10,888 to 10,890 feet and pumping mud below the packer, around the bottom of the casing and back into the casing through these perforations. A drillable retainer was set at 10,920 feet and the bottom joints of casing were then cemented with 100 sacks of slow-set cement. No squeeze pressure was applied. Cement was found in the casing at 10,885 feet and the perforations were tested satisfactorily before drilling the retainer.

Drilling operations continued on the University EE-1 until May 26, 1956, at which time the well surpassed the existing depth record of 22,570 feet. When a depth of 22,919 feet was reached, a protection string consisting of approximately 10,300 feet of 7⅝-inch and 12,600 feet of 7-inch casing was set and cemented. This cement job was the deepest ever performed up to that time. This combination casing string was run for two reasons. First, better safety factors in tension could be obtained by utilizing 7⅝-inch casing in the top portion of the string. Secondly, maximum possible clearance was needed in the upper part of the cased hole to accommodate the tapered drill string which was to be used for further drilling. The casing was cemented with 1,147 sacks of slow-set cement with 40 percent diatomaceous earth and 1.5 percent CMHEC slurried to 10.8 ppg. This lightweight slurry was followed with 100 sacks of slow-set cement containing 1.5 percent CMHEC and slurried to 15.8 ppg. At the time of running this string of casing the mud weight was 102 ppg, the Marsh funnel viscosity was 51 sec and the water loss was 4.4 cubic centimeters. Thickening times for the cement blends selected were determined in the laboratory before the job was performed. From a logged bottom-hole temperature of 295° F, which was recorded 8 hours after circulation was stopped, the bottom-hole circulating and static temperatures were assumed to be 260° F and 328° F, respectively. Thickening times were determined using these temperatures and an assumed bottom-hole pressure of 16,000 psi. Under these conditions, thicken-

TABLE 3—Secondary Cementing Operations in the Harral A-1

Type of Job	Retainer Depth (Feet)	Perforations (Feet)	Materials Used	Surface Squeeze Pressure (PSI)	Remarks
Squeeze	18,462	18,533–18,534	50 sacks Slow Set Cement, 0.3 percent CMHEC 8.5 millicuries iodine radio-active, slurry weight 15.7 ppg.	8000	Squeeze 35 sacks, reversed 15 sacks.
Squeeze	18,160	18,198–18,200	50 sacks Slow Set Cement, 0.3 percent CMHEC slurry weight 16 ppg.	8000	Squeezed 40 sacks, reversed 10 sacks.
Squeeze	15,795	15,833–15,835	Same as above.	8000	Squeezed 30 sacks, reversed 20 sacks.
Dump Bailer	18,740	18,820–18,900	2 sacks Slow Set Cement, 0.5 percent CMHEC	....	Dumped on top of bridge plug.
Dump Bailer	18,000	18,370–18,423	2 sacks Slow Set Cement, 2 percent CMHEC	....	Dumped on top of bridge plug.
Dump Bailer	17,500	17,888–17,938	2 sacks Slow Set Cement, 0.5 percent CMHEC	....	Dumped on top of bridge plug.
Dump Bailer	16,000	16,630–16,670	Same as above.	....	Dumped on top of bridge plug.
Squeeze	15,753	15,770–15,790	50 sacks same as above.	7400	Squeezed 45 sacks, reversed 5 sacks.
Dump Bailer	15,686	15,700–15,720	2 sacks same as above.	....	Dumped on top of bridge plug.
Dump Bailer	15,900	....	Same as above.	....	Dumped on top of bridge plug.
Dump Bailer	14,750	15,654–15,674	Same as above.	....	Dumped on top of bridge plug.

ing times of 5 hours for the lightweight slurry and 4 hours and 3 min. for the neat cement were obtained. It should be pointed out that the tests on the neat cement slurry were run with only 0.5 percent CMHEC mixed to 16.3 feet. However, the subsequent use of 1.5 percent CMHEC in the neat cement had no detrimental effects. The slurry could not be mixed above 15.8 ppg because of the high concentration of CMHEC but attained the desired strength upon setting as evidenced by the hard cement found in the bottom joints of casing when the floating equipment was drilled out. The top of the cement was located at 4,100 feet by temperature survey. This 18,819 feet column of cement is believed to be the longest ever placed in a single stage.

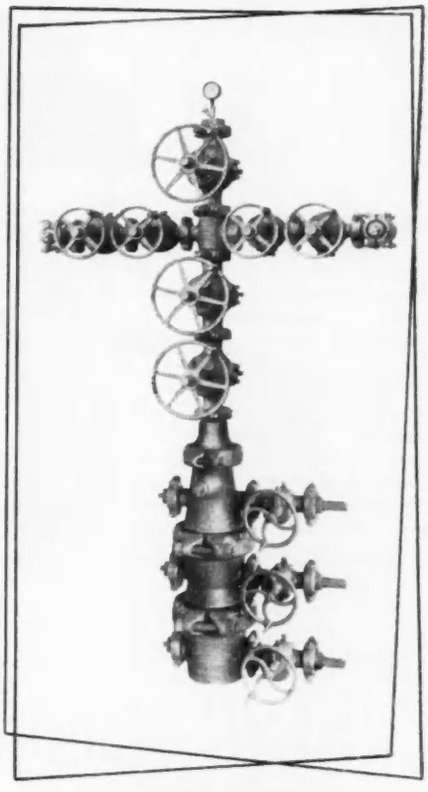
Prior to the previously described cement job, specially manifolded storage tanks which are normally used for hydraulic fracturing, were placed on location, and 10.2 ppg mud was stored in these calibrated tanks. The volume of mud necessary to displace the cement was calculated, taking into consideration a compressibility factor for the mud to be used. The cementing trucks were manifolded to these storage tanks so that the desired number of pumps could continue to dis-

TABLE 4—Secondary Cementing Operations in the University EE-1

Type of Job	Retainer Depth (Feet)	Perforations (Feet)	Materials Used	Surface Squeeze Pressure (PSI)	Remarks
Plug Back..... 22,829–22,575	.....	.....	50 sacks Slow Set Cement, 22½ percent Silica Flour, 2 percent CMHEC slurry weight 14.5 ppg.	....	Plugged 24 joints tubing with cement. Laboratory analysis of sample from dry blend indicated approximately 1 percent CMHEC in sample.
Plug Back..... 21,827–22,215	.....	22,310–22,500	Same as above.	....	Reversed 10 sacks.
Plug Back..... 19,465–19,143	.....	19,540–19,770	Same as above.	....	Reversed 6 sacks.
Squeeze..... (Stage 1)	13,960	14,000–14,060	100 sacks Slow Set Cement, 0.3 percent CMHEC slurry weight 16.5 ppg.	1000	Squeezed sacks, cleared perforations with 10 barrels of water.
Squeeze..... (Stage 2)	13,960	14,000–14,060	Same as above	5000	Squeezed 88 sacks, spotted 2 sacks on top of packer and reversed out 10 sacks of mixture.
Plug Back..... 13,210–	.....	13,248–13,320	75 sacks Slow Set Cement	....	Reversed out 5 sacks, Did not obtain plug.
Plug Back..... 13,210–12,800	.....	13,240–13,320	Same as above.	....	Reversed out 5 sacks. Successful plug with top of hard cement 12,850 feet.
Plug Back..... 8610–8340	.....	8650–8685	Same as above	....	Reversed 4 sacks.

TABLE 5—Secondary Cementing Operations in the Montgomery A-1

Type of Job	Retainer Depth (Feet)	Perforations (Feet)	Materials Used	Surface Squeeze Pressure (PSI)	Remarks
Squeeze.....	22,970	Open Hole 22,000–23,400	79 sacks, Slow Set Cement, 60 lbs. Barite per sack, 1.7 percent CMHEC slurry weight 16 ppg.	8000	Squeezed 60 sacks. Spotted 3 sacks on top of packer and reversed 16 sacks of mixture.
Plug Back..... 22,450–22,572	.....	22,650–22,880	27 sacks Slow Set Cement, 22½ percent Silica Flour, 2 percent CMHEC slurry weight 14.5 ppg.	....	Plug back necessary due to retainer failure. Retainer set at 22,572 feet.
Plug Back..... 21,352–21,756	.....	21,690–21,795	50 sacks Slow Set Cement, 22½ percent Silica Flour, 2 percent CMHEC slurry weight 14.5 ppg.	....	Unable to break down formation with 10,000 psi. Plug spotted to abandon zone. Reversed 15 sacks.
Squeeze.....	19,776	19,830–19,950	100 sacks same as above.	2600	Squeezed 90 sacks. Communication while squeezing. Reversed 10 sacks.
Squeeze.....	19,728	19,830–19,950	Same as above.	9000	Squeezed 92 sacks. Reversed 8 sacks.
Squeeze.....	19,556	19,650–19,713	75 sacks same as above.	5800	Squeezed 20 sacks. Communication established while squeezing. Thirteen sack plug put on top of retainer, 42 sacks reversed.
Plug Back..... 19,190–18,790	.....	.....	50 sacks Slow Set Cement, 22½ percent Silica Flour, 1.5 percent CMHEC slurry weight 14.8 ppg.	....	Reversed 10 sacks.
Squeeze.....	17,806	17,870–18,130	75 sacks same as above.	8300	Squeezed 63 sacks. Reversed 12 sacks.



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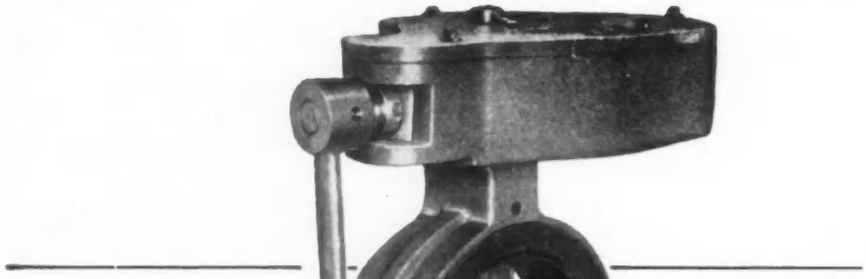

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place the cement as soon as the entire volume had been mixed. This procedure made it possible to accurately control the displacement rate and eliminate the necessity for each operator to attempt to keep accurate measurements while switching tanks on his individual pump truck. The amount of mud that had been pumped was known at all times while the cement was being displaced. A total volume of 951 barrels was required to displace the cement and bump the plug which followed the cement.

Drilling continued on this well until depth of 25,340 feet was reached. At this point, a 5-inch liner was run and cemented in 5¾-inch hole. The liner was cemented with 136 sacks of slow-set cement mixed with 20 percent diatomaceous earth and 3 percent CMHEC slurried to 12.3 ppg which yielded a total slurry volume of 340 cubic feet. Although lost returns were experienced with approximately one-half of the slurry still inside the liner, the cement was displaced without difficulty. A good primary cement job was obtained, and the top of the liner at 22,686 feet was tested satisfactorily. As no further drilling was to be done and the liner was to be perforated near the bottom, no neat cement was used around the bottom joints. It is preferable to complete through a diatomaceous earth cement rather than neat cement because of its better perforating characteristics. A number of cement plug backs were performed on this well during subsequent testing. Details of these jobs are included in Table 4.

The Montgomery A-1, located approximately 15 miles southeast of Fort Stockton, Texas, was drilled to a total depth of 23,400 feet. The four separate strings of casing which were set and cemented in this well are shown in Figure 3 (Part 1, WORLD OIL, November 1959). The first string was 1,424 feet of 2-inch surface casing set in 24-inch hole and cemented with 1,662 sacks of regular portland cement with a percent bentonite, followed with 300 sacks of regular portland cement. The bentonite cement was slurried to 14 ppg and the neat cement slurried to 16 ppg. Cement was circulated to the surface.

A 17½-inch hole was drilled to 5,046 feet and 13⅜-inch casing set at this depth. As previously mentioned, circulation was lost while cementing the 13⅜-inch casing in the University EE-1 well. For this reason, it was decided to cement this string in the Montgomery A-1 in two stages. A stage-cementing collar was set at 3,421 feet. The bottom stage was cemented with 302 sacks of regular portland cement with 40 percent diatomaceous earth and 4 percent calcium chloride slurried to 10.8 ppg, followed with 400 sacks of regular portland cement slurried to 15.4 ppg. The stage collar was opened and approximately 170 cubic feet of excess cement circulated out. Circulation was continued for 8 hours. The top stage was then cemented with 1,109 sacks of regular portland cement with 40 percent diatomaceous earth and 4 percent calcium chloride, followed with 100 sacks of regular portland cement. Again, the respective slurry weights were 10.8 and 15.4 ppg. Cement was circulated to the surface on the second stage. No lost returns were experienced on either stage. The neat cement was used on both stages for added strength around the bottom joints of casing and at the stage collar.

A 12¼-inch hole was drilled to 15,868 feet and an 8¾-inch reduced hole to 16,000 feet. Nine and five-eighths-inch casing was set at 15,868 feet. The mud weight at the time of running casing was 10.3 ppg. A stage-cementing collar was set at 9,756 feet. The bottom stage was cemented with 1,700 sacks of common portland cement with 40 percent diatomaceous earth and 0.75 percent CMHEC slurried to 10.8 ppg, followed with 364 sacks of slow-set cement slurried to 15.4 ppg. The stage collar was opened and approximately 200 cubic feet of excess slurry circulated to the surface. After the ports in the stage collar were opened, partial lost returns were experienced while circulating out the excess cement. When the lower-stage cement had attained its initial set, the top portion of the casing was cemented through the stage collar with 1,050 sacks of regular portland cement with 40 percent diatomaceous earth, followed with 300 sacks of neat slow-set cement. Cement was circulated to the surface on this top stage. The CMHEC was used in the first-stage cement primarily for a thicken-

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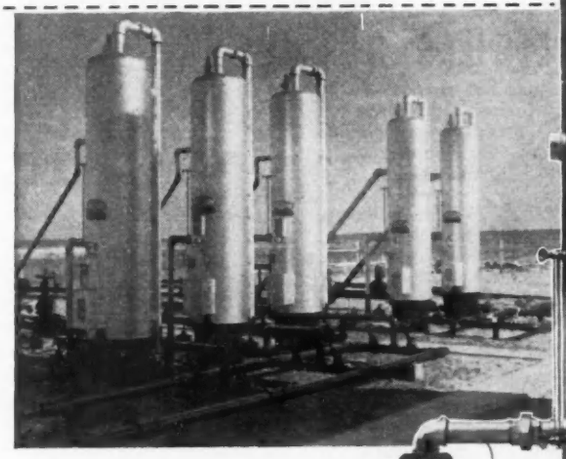
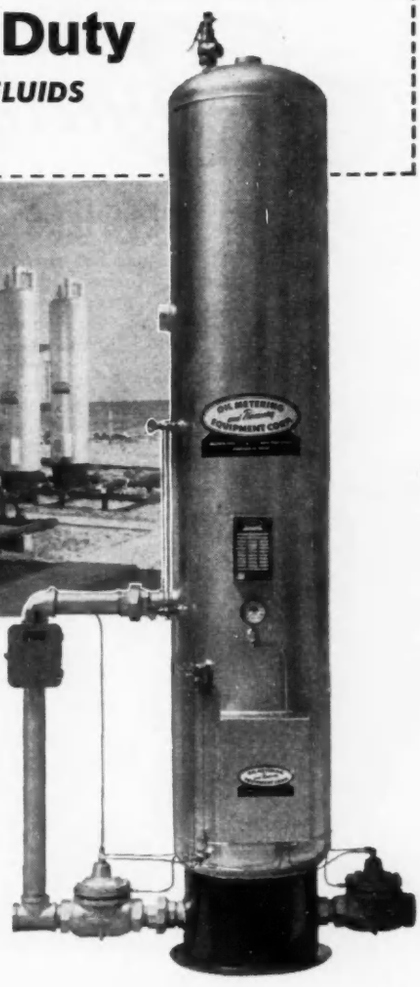


Battery of Model 24MS—0109C Type C Metering Separators



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New cement additives

Starts on Page 144

ing-time control agent rather than for fluid-loss control. The fluid loss of this particllar blend lies within the modified water-loss range obtainable with bentonite and calcium lignosulfonate slurries instead of the low-water-loss range normally associated with CMHEC slurry.

The last string of casing to be set in the Montgomery A-1 was the combination string of 7⅝-inch and 7-inch set at 23,000 feet, which at that time erased the record then held by the University EE-1 with a similar tapered string set to 22,919 feet. This well had a considerably higher bottom-hole temperature at 23,000 feet than the University EE-1 had encountered at this depth. The following temperatures were logged at 23,000 feet in the Montgomery A-1:

	°F.
16 hours after circulation.....	364
25 hours after circulation.....	365

The hole was then circulated for 6 hours and further temperature readings obtained:

	°F.
9 hours after circulation.....	347
15 hours after circulation.....	359
19 hours after circulation.....	362
28 hours after circulation.....	372

With the selection of 365° F as an average logged temperature, the bottom-hole circulating temperature was estimated at 344° F and the static bottom-hole temperature at 380° F.

The original cement recommendation for this job was slow-set cement blended with 16 percent diatomaceous earth and 2 percent CMHEC slurried to a density of 12.8 ppg. This slurry was to be followed with slow-set cement blended with 0.5 percent CMHEC and slurried to 16.3 ppg. When tested with cement and additions available in the laboratory, both slurries had thickening times of 4 hours or greater at the preceding temperature conditions. Separate laboratory tests on an actual sample of the cement which was available for this job disclosed that this shipment of cement did not respond to the thickening-time control of CMHEC as did the cement originally tested. Further tests showed it would be necessary to

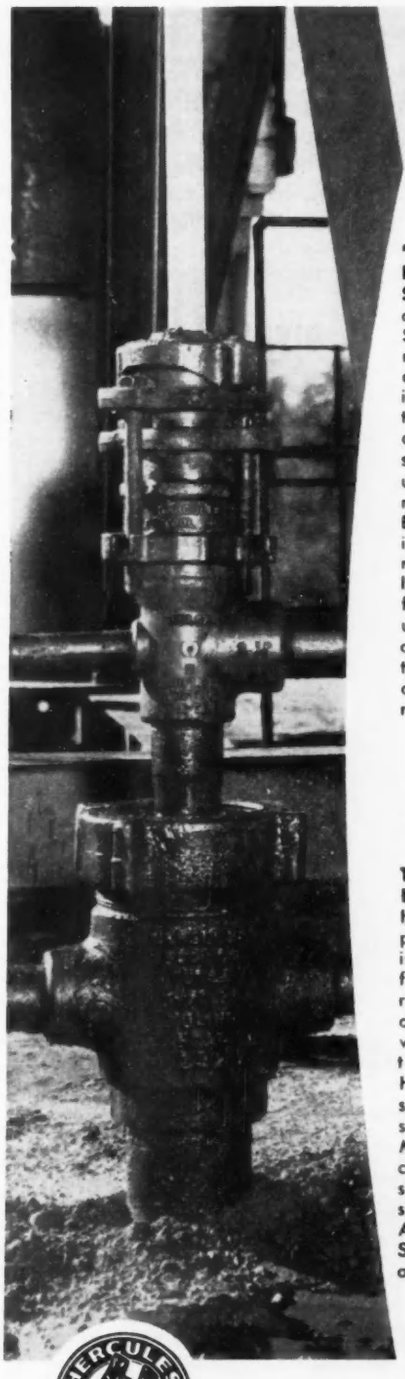
increase the CMHEC content to 2.5 percent in the light-weight cement slurry to obtain the desired thickening time. No increase in the CMHEC concentration for the neat cement slurry was found to be required.

After the casing was landed, mud was circulated for 12 hours before cementing was commenced. This long period of continuous circulation was considered to be desirable for two reasons. First, it was necessary to circulate the hole for an extended period of time to effectively remove the gas that had entered the well bore while running casing. It is believed that this reduced the chances of channeling of the cement and pressure buildup in the annulus following placement of the cement. Failure to remove all the gas-cut mud from the well bore prior to cementing the 5½-inch casing in the Harral A-1 is believed to have been a contributing factor in the pressure buildup between strings which occurred following the cement job. The second reason for the prolonged circulation period was to obtain the maximum cooling effect down-hole before cementing. Any additional cooling that could be obtained was an added safety factor for the successful placement of the cement. Again calibrated tanks containing the pre-determined volume of mud necessary to displace the cement were used.

After the 12-hour circulating period, the casing was cemented with the recommended cement system consisting of 1,099 sacks of the light-weight cement followed with 150 sacks of the neat cement. A temperature survey located the top of the cement outside the 7-inch casing at 15,839 feet or 29 feet in the 9⅝-inch casing. This was just a few feet lower than the calculated cement top prior to the job. If possible, this cement job was an even smoother operation than the similar job on the University EE-1.

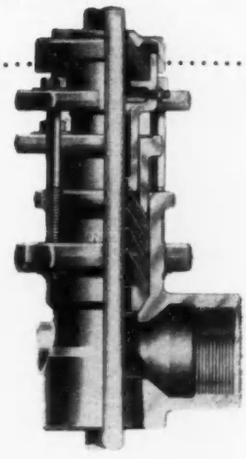
Drilling continued until the depth of 23,400 feet was reached. Prior to testing the 400-foot open-hole section, two bottom-hole temperatures were obtained with 500° F maximum thermometers. These temperatures were 438° F and 472° F for an average of 455° F. It is believed that the 472° F reading is the highest temperature ever recorded in a well. Testing in the interval yielded water, and it was de-

HERCULES products in ACTION

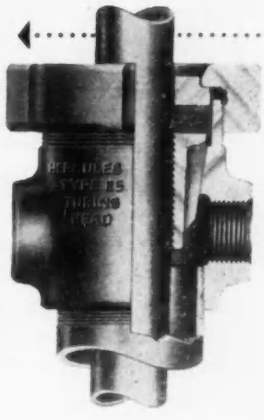


A typical set-up is shown below in Creek County, Oklahoma, using Hercules "Tee Type" Duplex Polished Rod Stuffing Box and Type "E5" Tubing Head. This is an easily assembled, effective and economical producing unit.

"TEE TYPE" DUPLEX POLISHED ROD STUFFING BOX—A combination Tee and Stuffing Box with female thread to screw directly onto the tubing, eliminating one threaded connection and resulting in a considerably shorter hook-up. With internal parts removed, the Stuffing Box body is full opening and need not be removed to pull rods. In addition to being furnished in the most used sizes, special combinations of threads and outlets can be furnished on request.



TYPE "E5" TUBING HEAD—This Tubing Head is ideal for any pumping situation. It is economical enough for shallow wells and rugged enough for any depth well, with working pressure up to 1500 pounds. Hercules self-aligning slips suspend the inner string in this Head. Mandrel suspension can be furnished instead of slips, if desired, at no extra cost. A neoprene Tubing Stripper Unit is also available.



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New cement additives

Starts on Page 144

sired to squeeze cement the open-hole section. The squeeze job was accomplished through a tapered string of 3½-inch and 2⅞-inch tubing and a permanent production packer set at 22,970 feet. Mud was circulated for 11½ hours at the top of the packer to cool the hole prior to squeezing. The tubing was tested to 10,000 psi and the surface connections to 13,000 psi. The open hole was then squeezed with 79 sacks of slow-set cement blended with 60 pounds of barite per sack of cement and 1.7 percent CMHEC by weight of the cement. The total yield was 150 cubic feet of slurry mixed to 16 ppg. Final squeeze pressure was 8,000 psi at the surface with 114 cubic feet of the slurry below the packer. The seals were pulled from the packer and 6 cubic feet of slurry displaced on the top of the packer. The remaining slurry volume of 30 cubic feet was reversed out from 22,940 feet. The squeeze was accomplished 2 hours from the time cement mixing began, and the job was completed in 3 hours, which included displacing the cement on top of the packer and reversing out the excess cement. The thickening time for this blend was 4 hours at 380° F. For a primary cement job, the water-to-cement ratio in this 16 pound per gal slurry would have been considered excessive. However, on this open-hole job, any excess water would be squeezed from the slurry resulting in a good cement mixture on bottom. A brief summary of subsequent squeeze jobs and plugbacks on the Montgomery A-1 is shown in Table 3. Additional laboratory information obtained about the time of the open-hole squeeze jobs by using silica flour instead of or in conjunction with barite. These data are shown in Table 1 (Part 1, WORLD OIL, November 1959). Recommendations were then made for the subsequent jobs at various depth in both the Montgomery A No. 1 and the University EE-1. These recommendations are shown in Table 2 (Part 1, WORLD OIL, November, 1959).

Discussion. It should be mentioned that casing centralizers were used on the bottom portion of each casing string with the exception of conductor or shallow surface strings and those deep strings where restricted hole sizes would not permit their use, such as the 5-inch liner which was run in 5¾-inch hole in the University EE-1. Centralizers were also spaced above and below each stage collar used. Wall scratchers were not used on the production strings because it was not considered advisable to attempt rotation or reciprocation at the extreme depths involved.

Open-hole caliper surveys were available for use in calculating cement-volume requirements on all casing jobs except the surface strings. Occasionally, excess cement was added to the calculated requirement obtained from the caliper survey to assure that the desired fill-up would be obtained. Desired fill-up was obtained on all but two primary jobs.

On some of the cement jobs discussed where gas-cut mud had been experienced, pressure was applied to the annulus at the surface after the

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cement had been placed and this pressure left on the annulus until the cement had attained its initial set. This was done in an effort to prevent migration of fluids, particularly gas, from the formation into the well bore while the cement slurry was still in a fluid state. In no case was an amount of pressure applied which would endanger breaking down the formation behind the casing. The effectiveness of this procedure is not definitely conclusive, but may have merit in some instances.

When testing the proposed cement blend for the 5-inch liner in the University EE-1, it was found that retardation of cements at high temperatures becomes increasing more difficult as slurry densities are decreased below approximately 13.5 ppg. As previously discussed, the cement used on this job was a 20 percent diatomaceous earth blend slurried to 12.3 ppg. It was necessary to use 3 percent CMHEC by weight of the cement in the slurry to obtain the desired retardation.

On each of the deeper cement jobs where a large volume of cement was used, it was desired to mix and displace the cement at an optimum rate without stopping the movement of the slurry at any time until the follow-up plug was bumped. The cement bins and trucks were located and manifolded in such a manner that the number pumps mixing or displacing the cement could be varied as required. Depending upon the particular job, one or two standby trucks were connected into the manifolding system as an additional safety precaution. On these more critical jobs, a special plug container was used which permitted releasing the follow-up plug without stopping the movement of the cement slurry.

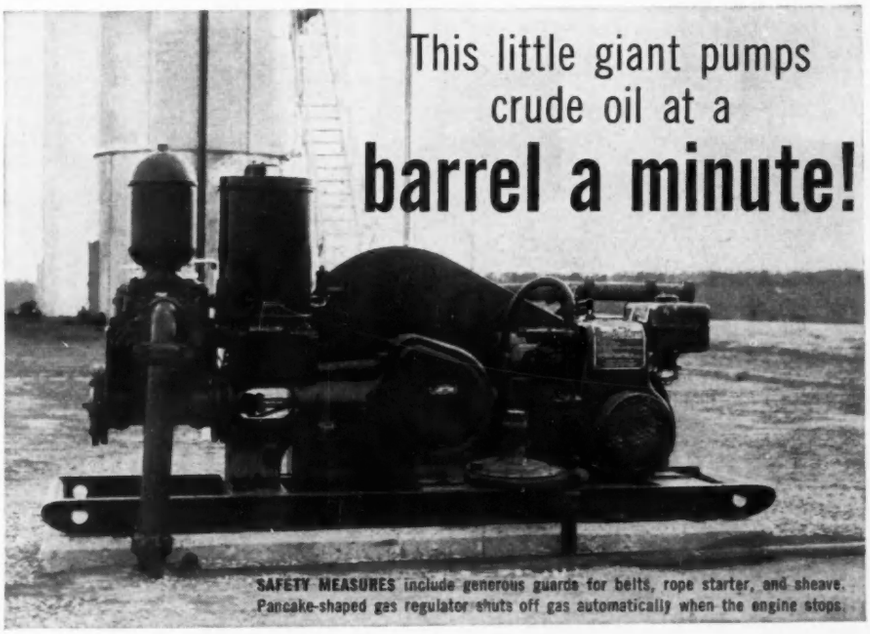
The successful accomplishment of the cement jobs performed in the Pecos County wells can be attributed to careful selection and pre-testing of materials, and advanced planning of the jobs between the cementing service company and the operator.

Several conclusions were reached during the process of testing of cement blends in the laboratory:

- At bottom-hole temperatures above 260° F it is advisable to test the cement blend to be used before the job is performed.
- Retardation of light-weight cements at high temperatures becomes more difficult as slurry weights are decreased below 13.5 ppg.
- A cement blend having far superior qualities for deep, high-temperature squeeze jobs can be obtained by using silica flour.

In cementing these deep wells, all materials used are commercially available and no experimental additives were used. The performance of both materials and cementing equipment was highly satisfactory even under the most severe well conditions.

(This paper was presented before the spring meeting of the Southwestern District Division of Production, API, Midland, March 1959. The authors wish to express their appreciation to Phillips Petroleum Company and to Halliburton Oil Well Cementing Company for permission to publish this paper. Acknowledgment and appreciation are also expressed to Dr.



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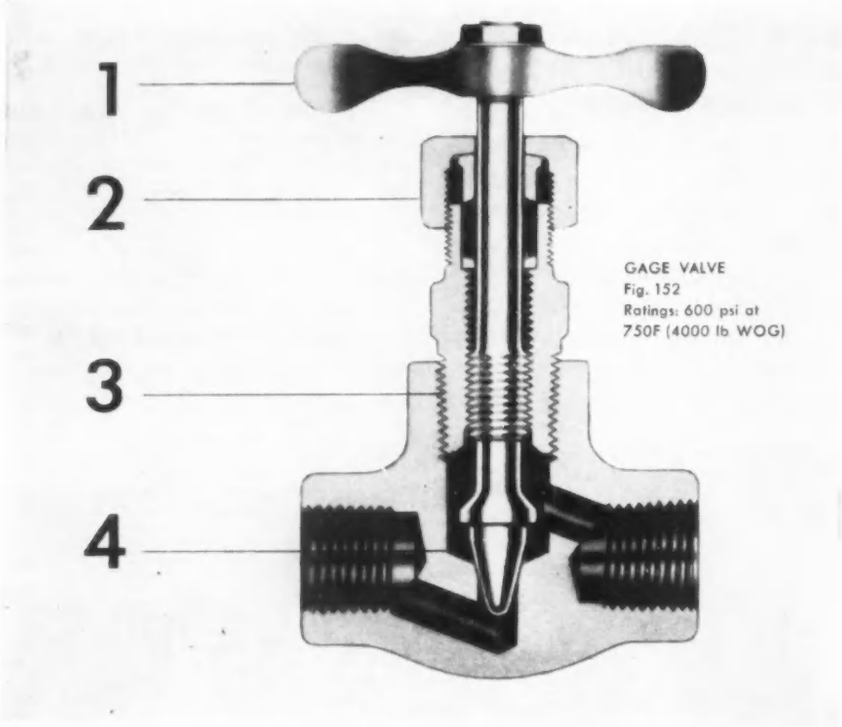

GAGE VALVE
Fig. 152
Ratings: 600 psi at
750F (4000 lb WOG)

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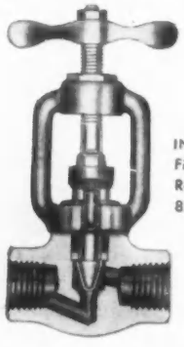

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Starts on Page 144

F. J. Shell of Phillips Petroleum Company, under whose direction the cement blends used were formulated and tested, and to Frank M. Saye and T. D. Pugh of Halliburton Oil Well Cementing Company, who assisted in the accumulation of data and final preparation of this paper.)

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What's Happening among MEN in the INDUSTRY

E. A. Hugill, Jr.

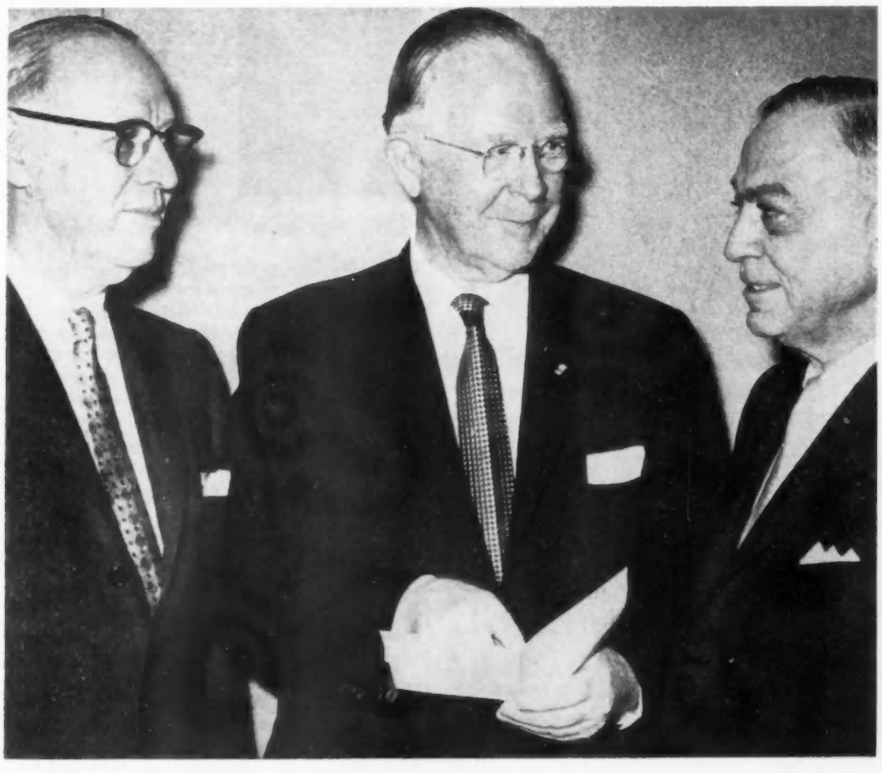
E. A. Hugill, Jr., has been elected secretary of **Shell Oil Company.** Hugill was also appointed secretary of Shell Chemical Corp., International Lubricant Corp., and Shell Canadian Exploration Company. He succeeds **J. A. Horner** as secretary of those companies.

Dr. Fred W. Burtch has joined the Well Stimulation Section of the Production Engineering Division of **Gulf Research & Development Company,** Pittsburgh. He will work on chemical methods of oil well stimulation.

Basil P. Kantzer, vice president for Gulf Division, **Union Oil Company,** has become vice president in charge of exploration for the United States (including Alaska) and Canada. **K. C. Vaughn,** manager of natural Gas and Gasoline Departments, has become manager of operations for Union's Gulf Division at Houston; **J. R. Frazer,** assistant to Vaughn, replaces him as manager of the department at Los Angeles; **E. C. Babson,** manager of operations for the Canadian Division, has transferred to California headquarters as manager of foreign operations. **E. W. Scott,** staff geological coordinator, replaces Babson as manager of the Canadian Division at Calgary, Ont.; **E. R. Atwill,** manager of operations for the West Texas Division, transferred to California for special assignment to the Exploration Department staff. **Ray A. Burke,** chief geologist for the Gulf Division, has become manager of the West Texas Division.

Earl J. Cox has joined the staff of the **State Geological Survey** in Vermillion, S.D., as a petroleum geologist.

Mobil Oil Company has announced the appointment of **Albert F. Barrett** as manager of producing and **Arne Nielsen** as manager of exploration for the new Denver Exploration and Producing division of Mobil.



Testimonial Dinner for the General

General Ernest O. Thompson (center), chairman of the Texas Railroad Commission, was the guest of honor at a testimonial dinner held in Houston recently. Some 50 friends of General Thompson sponsored the fete. William A. Smith (left) and Robert H. Abercrombie (right) served as chairmen. A crowd of some 1,100 attended the dinner which was a salute to General Thompson's leadership in public service that has spanned more than three decades. He has been a member of the Railroad Commission for 27 years.

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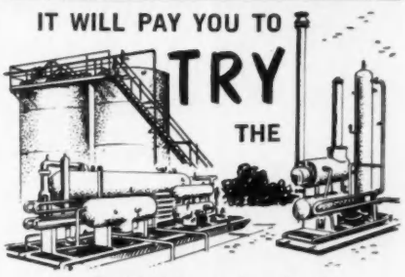

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Dr. B. N. Rolfe

Dr. Bernard N. Rolfe, formerly with the United States Geological Survey and a consultant on waterflood recovery, has joined **Sinclair Research Laboratories, Inc.,** Tulsa, as an assistant director of the Exploration Research Division. He will be assistant to **James F. Johnson.**

Homer O. Woodruff has been appointed assistant to **A. W. Baucum,** vice president in charge of the Domestic Producing Department of **Texaco Inc.**

A. C. Rose, Jr., has resigned as associate director of the **Louisiana Petroleum Council** to accept the position of executive vice president with the **Colorado Petroleum Committee. John H. (Jack) Francis, Jr.,** has been appointed associate director of the LPC in Baton Rouge, La., replacing Rose.

Eugene Hosford of Houston, and **Cecil Colville** of Dallas, were appointed recently to top positions in the **Texas Oil Information Committee.** Hosford, operations coordinator of the Domestic Production Department of the **Gulf Oil Corporation,** was appointed executive vice chairman and Colville, administrative assistant to the management of **Sun Oil Company's** Southwest Production Division, was appointed community program vice chairman.

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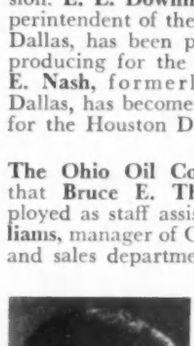
J. E. Wilson

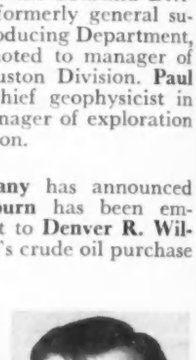
J. E. Wilson, acting Houston area exploration manager for **Shell Oil Company,** has been nominated to succeed **E. D. Cumming,** vice president of Shell's Houston area when Cumming retires at the end of this year. Wilson was named to his present position in July of this year.

Wade G. Moroarty, formerly assistant general superintendent in the Producing Department, Dallas, for **Mobil Oil Company,** has been named manager of producing for the Midland Division. **Owen H. Blexrud,** formerly area geologist in the Dallas Exploration Department, has become manager of exploration for the Midland Division. **E. L. Downing,** formerly general superintendent of the Producing Department, Dallas, has been promoted to manager of producing for the Houston Division. **Paul E. Nash,** formerly chief geophysicist in Dallas, has become manager of exploration for the Houston Division.

The Ohio Oil Company has announced that **Bruce E. Thauburn** has been employed as staff assistant to **Denver R. Williams,** manager of Ohio's crude oil purchase and sales department.



J. C. McCarthy



C. A. Brooke, Jr.

Pan American Petroleum Corporation has announced key personnel changes in its Texas-Louisiana Gulf Coast division Exploration and Producing departments. **Alvin R. Winzeler** has been appointed division exploration superintendent, replacing **J. C. Johnston,** who has transferred to Tulsa as manager of exploration. **J. C. McCarthy** has been named assistant division production superintendent, replacing **George C. Wight,** who has transferred to Pan American's foreign subsidiary, **Pan American International Oil Company** at New York City. **C. A. Brooke, Jr.,** has been appointed division geologist, replacing **R. S. Tremaine,** Pan American's new geological research director at the firm's research center in Tulsa.

A. R. Winzeler

James L. Dougherty, labor relations supervisor for **Lion Oil Division** of **Monsanto Chemical Company,** has been named to the newly created position of personnel manager of the division's production and Exploration Department, Houston.

Sinclair Oil Corporation has announced the election of **Lee M. Fuller** to assistant treasurer of the corporation and **J. P. Downer** has been appointed an assistant treasurer of the corporation. Fuller joined Sinclair Refinery Company in 1922. Downer joined Sinclair in 1959.

Lee M. Fuller

Frank B. Markel, Wayne V. Jones and **Daniel B. Lovejoy** have been elected senior vice presidents of **Union Oil and Gas Corporation of Louisiana.** All three men were formerly vice presidents. **Donald K. Hawes,** formerly secretary and assistant treasurer, was appointed secretary and treasurer. **Maxwell L. Euwer,** vice president, was named general manager of domestic production. **Elliot H. Powers,** vice president, is now general manager of domestic production exploration; and **William H. Woods,** vice president of **Runnels Gas Products Corp.,** wholly owned subsidiary, is now general manager of the parent company's Gas Department.

Pan American Petroleum Corporation has named **R. A. Feagan, Jr.,** North Texas-New Mexico division gas superintendent. Feagan replaces **J. C. Conner** who moved to Chicago on special assignment with **Standard Oil Company (Indiana),** Pan America's parent firm.

William A. Zellars has been appointed branch manager in Tulsa for **Eggelhof Engineers, Inc.** At the same time, the resignation of **Cliff Lindsey** was announced. Lindsey will enter business in Oklahoma City.

H. L. Mendenhall has been promoted to assistant chief geologist of **Phillips Petroleum Company's** Land and Geological Department in Bartlesville, Okla. He succeeds **C. D. Hier** who has transferred to the company's International Department.

Mobil Oil Company de Venezuela has selected **Dr. Luis Eduardo Arocha,** legal adviser for Mibol Oil, to the firm's board of directors. Dr. Arocha joined Mobil in 1954 after a career which included 6 years of civil law at the Universidad de los Andes in Merida, Venezuela.

Dr. L. E. Arocha

C. L. (Slim) Fowler, California drilling contractor, has disposed of all his interest in **Fowler Drilling Company.** The firm will now be under the sole direction of his previous partner **Carl T. Gates.**

Standard Oil Company (Indiana) has elected **Merwin Bristol** a director and general counsel. Bristol was formerly associate general counsel. **Richard J. Farrell,** assistant general counsel, was named to succeed Bristol as associate general counsel. Bristol succeeds **Thomas E. Sunderland** who resigned.

Walter J. Brunmark has been elected to the Board of Directors of **Southern California Petroleum Corporation.**

Ira B. Loyd, who has been field representative of the division at Casper, Wyo., for **Texaco Inc.,** has been appointed head of the Tulsa office of crude oil purchases and sales division replacing the retired **E. W. Russell.**

Edwin P. Davis has joined the **McElroy Ranch Company** Fort Worth office as manager of exploration. Prior to joining McElroy, Davis was associated with British-American Oil Producing Company.

Shell Oil Company has announced formal organization of their new southwest Louisiana Land and Exploration divisions with headquarters in Lafayette. **G. W. Harris, Jr.,** former senior landman in Shell's Tulsa office, was named division land manager, and **J. K. Larsen,** formerly of Baton Rouge, will be the division exploration manager.

William E. Spear has joined **Shell Oil Company's** Los Angeles office Production Department staff as senior mechanical engineer. Spear had served as senior mechanical engineer in Denver before his California transfer. He was division mechanical engineer at Billings, Mont., before his Denver assignment.

W. E. Spear

C. E. Starr, Jr., has been appointed a deputy coordinator, an executive post in the general administration unit of **Esso Research and Engineering Company.**

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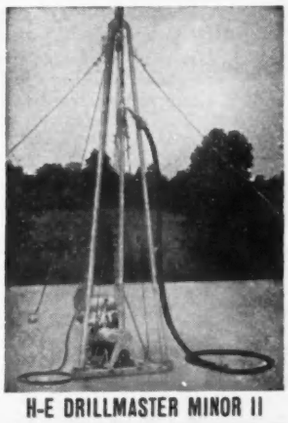

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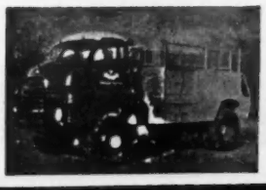

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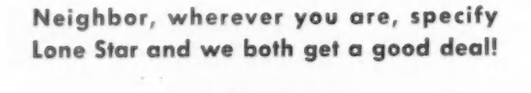

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Pan American Petroleum Corporation has announced three key personnel changes affecting its Canadian Division Exploration Department. **John C. Meeker** has been appointed as division exploration superintendent, replacing **Alvin R. Winzeler,** who transferred to Pan Am's Texas-Louisiana Gulf Coast Division in Houston as exploration superintendent. **Michael R. Waller** has been promoted to Canadian Division geologist, and **Howard W. Schwartz** has been promoted to the position of Calgary District geologist.

Tidewater Oil Company has appointed **H. F. Tomfohrde** to the post of transportation manager, home office. Formerly manager of Tidewater's Eastern Division Transportation and Supply Department, Tomfohrde will make his headquarters in Los Angeles. In his new post, Tomfohrde will develop and coordinate policies, plans and procedures covering all phases of Tidewater's nationwide transportation activities.

H. F. Tomfohrde

William R. Duncan has been appointed field superintendent for **Well Completions, Inc.** For the past 2 years Duncan has been in charge of the company's Texas Panhandle District.

Loffland Brothers Company has announced a number of key appointments under Loffland's new organizational setup. **William J. Weaver,** secretary-treasurer, has been appointed manager of administrative services. **Thomas W. Wheeler,** formerly vice president of contracting, has been promoted to executive vice president of Loffland's domestic companies. Also, four new general division managers were named and they include **Rex Parks, Henry O. Heckert, J. Warren Perry** and **William C. Walker.**

Gulf Oil Corporation has elected **R. O. Rhoades,** a director and executive vice president, as Board Chairman replacing **David Proctor** who has resigned.

Bart De Laat and Associates, consultants in petroleum and natural gas, Houston, have announced that **J. D. Driskill, Jr.,** has joined their firm as an associate engineer.

Shell Oil Company has made three staff changes in their legal organization. **O. L. Stone,** presently a general attorney, will now handle exploration, production and industrial legal matters. He will act for the vice president and general counsel in his absence. **S. R. Vandivort,** an attorney at head office, New York, has been named a general attorney. He will handle manufacturing, transporting and supplies, marketing, purchasing-stores and public relations legal matters. **R. M. Hart,** also an attorney at head office, was named a general attorney and will handle legal matters concerning financial, including taxes, the secretary's office, personnel, including benefit plans and Shell Development Company.

Plymouth Oil Company has announced that **Jerry M. Ewers** has joined that firm as regional geologist at Denver. Ewers was formerly vice president of Alex W. McCoy Associates, Inc.

AAODC Presents Service Awards

Honored for their outstanding contributions to the drilling industry, these eight men were presented Meritorious Service Awards recently by the American Association of Oilwell Drilling Contractors at its Nineteenth Annual Meeting in Oklahoma City. The awards, presented for the first time this year, are designed to pay special tribute to both members and non-members of the association who have advanced the science and status of the oil well drilling industry. Standing (left to right): Stanley Moore, Drilco Oil Tools, Inc., Midland, Texas; Will I. Lewis, Will I. Lewis Drilling Company, Mt. Vernon, Ill.; John Woodruff, Petroleum Extension Service, The University of Texas, Austin; H. W. Davidson, Davidson Drilling Company, Inc., who received the plaque for his brother, C. J. Davidson, Fort Worth; F. A. (Pug) York, Miller & York, Inc., Bakersfield, Calif.; Henry Woods, Hughes Tool Company, Houston; Arthur Lubinski, Pan American Petroleum Corporation, Tulsa. Seated: Earle C. Flesher, Johnson & Flesher Drilling Company, Oklahoma City.

Sun Oil Company has announced the appointments of **Arthur S. Berger** as division land manager and **Richard W. Coates** as division general attorney for Sun's Rocky Mountain Division with headquarters in Denver. **Leland A. Idler** succeeds Berger in his former position of manager, Title Records Department. **Frank Neighbor** has been named to the newly created position of district exploration manager at Casper, Wyo. **Dr. J. Frank Harvey** succeeds Neighbor at Salt Lake City, Utah, as district geologist. Other Rocky Mountain Division appointments include: **Porter E. Noble** as junior attorney, Denver; **William F. Prescher,** district geologist, Casper; **Pat Sullivan,** junior landman, Casper; and **Mathew S. Tudor** as senior geologist, Bismarck, N.D.

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Horne Well Service Co. 3-5396
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HOUSTON, TEXAS
Assoc. Eng. & Eqpt., Inc.....CA 5-1103
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Mid-Western Well Ser. Co.....RE 4-4262
HOUSTON, TEXAS
Long Line Production Co.....GR 3-5739
LAFAYETTE, LOUISIANA
Assoc. Eng. & Eqpt., Inc.....CE 5-6770
Cameo, Inc. .....CE 5-3124
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MIDLAND, TEXAS
Luccous Service & Eqpt. Co.....MU 2-1631
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Assoc. Eng. & Equip. Inc.....UP 2-0347
ODESSA, TEXAS
Cameo Wire Line Service, Inc.....FE 2-6487
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Rainbo Service Co.... ME 4-2131, ME 4-0105
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Eddie Jones Eng. Co., Pettus 16, Beeville, FL 8-1218
SHREVEPORT, LOUISIANA—Cameo, Inc.... 8-3615
VICTORIA, TEXAS—Cameo, Inc.....HI 3-9521
WHITTIER, CALIFORNIA
Kline Wire Line Co. .....OX 3-2731
WICHITA FALLS, TEXAS—Hudson-Eads, Inc.
322-8584, 322-1792, 767-8727, 723-4690, 767-3793

T. N. Law, Jr.

T. N. Law, Jr., exploration and landman, has been appointed vice president in charge of intercompany and public relations for **Falcon Seaboard Drilling Company,** Tulsa. Law will continue his duties with the Exploration Department but will be in charge of an expanded internal and public relations program for the company.

Buttes Gas & Oil Company elected **Edward M. Harbison** and **Joseph Edleman** to the Board of Directors.

John B. Carrier, geologist for Superior Oil Co., has resigned to become a consultant at Casper, Wyo.

Kerr-McGee Oil Industries, Inc., stockholders re-elected the following directors to serve during the coming year: **Robert S. Kerr, D. A. McGee, T. M. Kerr, F. C. Love, Breene M. Kerr, Robert S. Kerr, Jr.,** and **J. B. Saunders,** all of Oklahoma City; **J. D. Blosser, Guy C. Kiddoo, Frederick W. Straus** and **Dean Terrill,** Chicago; **Edwin L. Kennedy,** New York; **James E. Webb,** Washington; and **J. H. Lollar, Jr.,** Houston.

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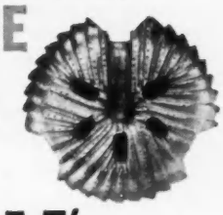

In a recently completed hole in British Columbia a series of conventional rock bits averaged only from one to two feet per hour. The longest run was 31 ft.... the shortest 9′.

At this point a Hycalog V-DOOR was run. From 6709′ to 7229′, it averaged 5.7 ft./hr., a performance so unbelievable that the string was pulled to check on the bit. *Still in excellent condition,* it was rerun. The balance of the run to 7734′ was completed... also at an average of 5.7 ft./hr.... and the bit was still in good condition.

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DIAMOND BITS DIAMOND CORING
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Curtis J. Little, district geologist of the Lion Oil Division of Monsanto Chemical Company at Albuquerque, N.M., has resigned to become a consultant there.

Pan American Petroleum Corporation has promoted **John W. Phenicie** to assistant division production superintendent, Rocky Mountain Division Production Department. **Donald H. Falkingham** has replaced Phenicie as division engineer. **J. C. McCarthy,** formerly Rocky Mountain assistant division production superintendent, has been transferred with the same title to Pan Am's Texas-Louisiana Gulf Coast Division at Houston.

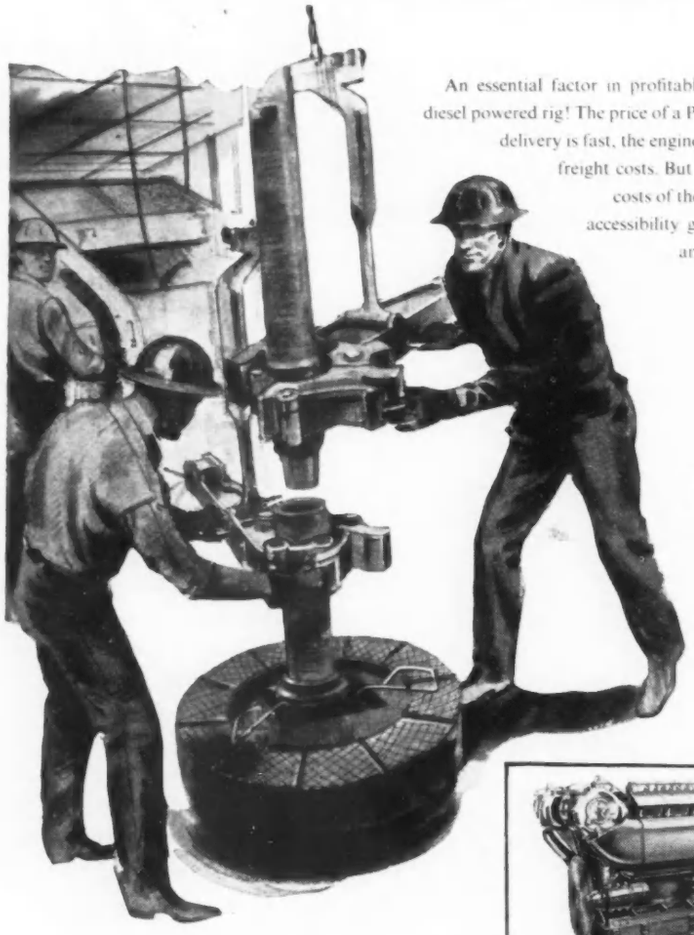
Alfons Landa, chairman of the Board of **Reiter-Foster Oil Corporation,** and **Emil V. Hegyi,** president, were elected to the Board of Directors of **Consolidated Royalty Oil Corporation.**

Jerome J. Wright, formerly exploration superintendent and chief geologist for **The Coronet Oil Company,** has opened a foreign and domestic consulting office with headquarters in Midland, Texas.

J. J. Wright

Mobil Oil Company has appointed **William H. Montgomery** general manager of the Manufacturing Department of Mobil. For the past 12 years Montgomery has been general manager of employe relations of Socony Mobil Oil Company, Inc.

Down-to-earth facts about 'PAXMAN' rig power



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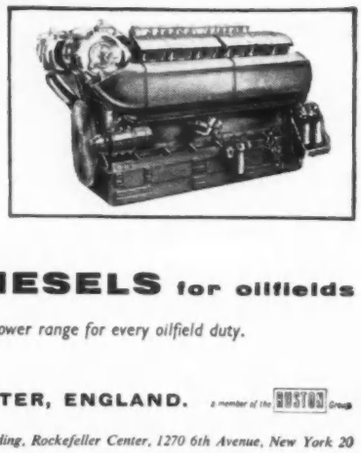
Just check on it – and you will find why so many Paxman diesels are in oilfield service today . . . *and have been for years!*



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Spares service facilities to match oilfield requirements.

P03

William R. Whitley has been elected an assistant vice president of the **Republic National Bank of Dallas.**

Sunray-Mid-Continent Oil Company has elected **M. Darwin Kirk** and **Stanley D. Breitweiser** directors. Both succeed positions formerly held by **Edward Howell** and **E. M. Razer,** respectively, both of whom have retired and resigned from their long-held directorates.

Lawrence J. O'Connor, Jr., has been named assistant director for office of Oil and Gas, **U.S. Department of The Interior.**

Pure Oil Company has appointed **Ira Needham, Jr.,** acting manager of Pure's Rocky Mountain Producing Division with headquarters in Denver. Needham succeeds **Harris Van Zandt** who has become general manager of all Pure's domestic and foreign exploration and production operations.

Oliver J. Kangas has been appointed head of the new Mechanical Division of **Esso Research and Engineering Company. Russell Boettger** has been named assistant manager. Other appointments in the new division also were announced. Named to the post of section head are **Ernest Musslewhite, Robert R. Risher** and **Raymond A. Vansweringen.**

Harry Jefferies

Iver J. Bergholt

W. F. Dau

H. C. Sheperd

Harry Jefferies, director and executive vice president of **Sinclair Oil Corporation,** was elected also as chairman of the Finance Committee, a newly created post. **Iver J. Bergholt,** assistant treasurer and vice president, was elected treasurer succeeding **W. F. Dau** who has retired. Also, **Howard C. Sheperd** was elected a member of the Board of Directors.

R. C. Curtis, president of **Jersey Production and Research Company,** Tulsa, has been elected to the Board of Directors of **Esso Research and Engineering Company.**

J. A. Rogers, former chief geologist of the Domestic Producing Department of **Texaco Inc.,** has been appointed assistant division manager of the New Orleans Division. Rogers succeeds **L. W. Calahan,** now division manager of the Dallas Division.

WHO'S MEETING WHERE

Dec. 3–5	Interstate Oil Compact Commission, Sheraton Hotel, Philadelphia.
7	AIME, Arizona Section, Annual Meeting, Tucson, Ariz.
20	Oil Trades Association of New York Meeting, Waldorf-Astoria Hotel, New York City.
Jan. 4–15	Advanced Drilling Engineering Course, Texas A. & M. College, College Station, Texas.
11–13	First International Symposium on Arctic Geology, Jubilee Auditorium, Calgary, Alberta.
28–29	Houston Section NACE, Two Day Course in Practical Corrosion Control Systems for Oil & Gas Production, Rice Hotel, Houston.
Feb. 8–10	AAPG, Rocky Mountain Section, Tenth Annual Meeting, Billings, Mont.
14–18	AIME, Annual Meeting, Statler Hotel, New York City.
Mar. 2–4	API, Division of Production, Southwestern District Meeting, Statler-Hilton Hotel, Dallas.
14–18	NACE, 16th Annual Meeting, Memorial Auditorium, Dallas.
16–18	API, Division of Production, Southern District Meeting, Hilton Hotel, San Antonio, Texas.
23	Oil Trade Association of New York Meeting, Waldorf-Astoria Hotel, New York City.
30 thru Apr. 1	API, Division of Production, Mid-Continent District Meeting, Broadview Hotel, Wichita, Kan.
April 20–22	API, Division of Production, Rocky Mountain District Meeting, Gladstone, Henning and Townsend hotels, Casper, Wyo.
20–22	NPA, Semi-annual Meeting, Hotel Cleveland, Cleveland.
21–23	Permian Basin Section SEPM, Annual Meeting and Field Trip, Abilene, Texas.
24–26	IPA of America, Mid-Year Meeting, Denver-Hilton Hotel, Denver.
25–28	AAPG-SEPM, Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N.J.
25– thru May 6	Advanced Drilling Engineering Course, Texas A. & M. College, College Station, Texas.
May 1–4	API, Division of Transportation, Tanker Conference, Seaview Country Club, Absecon, N.J.
2–3	SAE of AIME, Wichita Falls, Texas.
2–4	AIME, North Texas Secondary Recovery Symposium (Biennial), Wichita Falls, Texas.
5–6	AIME, Rocky Mountain Petroleum Sections, Annual Joint Meeting, Calgary, Alb., Canada.
12–13	API Division of Production, Pacific Coast District Meeting, Biltmore Hotel, Los Angeles.
25–28	AAPG, Western Canada Reginal Meeting, Banff Springs Hotel, Banff, Alberta.
June 5–10	SAE, Summer Meeting, Edgewater Beach Hotel, Chicago.
12–17	API Division of Production, Mid-year Committee Conference, Sheraton-Dallas Hotel, Dallas.
28–30	API Division of Production, Eastern District Meeting, Greenbriar Hotel, White Sulphur Springs, W. Va.

Nomads' Chapter monthly meeting: Los Angeles, second Wednesday, Hotel Biltmore, Wallace A. Sawdon, Secretary. Houston, second Monday, Ye Old College Inn, Harry E. Estes, Secretary. Dallas-Fort Worth, first Monday, Greater Dallas Club, Hank Davis, Secretary. Tulsa, Hotel Tulsa, Gilbert Swift, Secretary. New York, first Monday, Hotel Biltmore, Jesse E. Hickman, Secretary.

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SAVE UP TO 60% IN PIPING COSTS!

Now there's no need to buy overweight pipe. Thanks to Victaulic engineering, you can select lightweight pipe "job-rated" to your conditions and install it the *new VIC-EASY way*. You'll cut costs of pipe, transportation, and handling —you'll save from 30% to 60% in man-hour installation.

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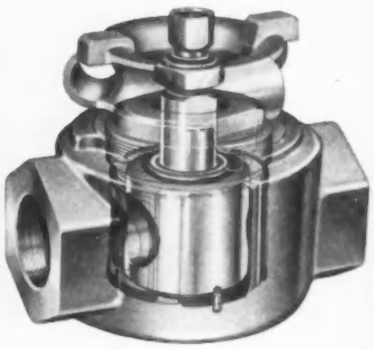

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2. **Plug can't stick or freeze.** Elastomer backing on seat segments permits micro-floating effect. Design insures free-turning plug under all operating conditions.
3. **Can be rebuilt right in the line in 10 minutes.** Low-cost factory replacement part kit permits reconditioning the valve to like new efficiency.
4. **Parts reversible**—can't be installed backwards. Seat segments may be turned end for end and still fit properly. Also parts are interchangeable within any given size.
5. **Valve weighs less, costs less**—approximately 40% lighter than similar service valves. It is smaller in size. And it costs 20% to 40% less than similar service valves.

Hamer VALVES
DIVISION OF CHIKSAN COMPANY
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Company_____
Title_____
City_____ Zone____ State_____

*59-5

what's Happening

among INDUSTRY ASSOCIATIONS

M. J. Rathbone Elected Chairman of API

M. J. Rathbone

F. M. Porter

L. E. Fitzjarrald

B. B. Reeve

R. E. Loeck

J. S. Sherborne

E. T. Knight

E. F. Perkins

D. V. Carter

J. T. Dickerson

F. R. Clark

T. E. Sunderland

M. J. Rathbone, president of Standard Oil Company (New Jersey), New York, was elected chairman of the board of the American Petroleum Institute at its Thirty-Ninth Annual Meeting in Chicago, November 9-11. Rathbone succeeds H. S. M. Burns, president of Shell Oil Company, New York.

Frank M. Porter, president of Fain-Porter Drilling Company, Oklahoma City, was re-elected president.

Other officers elected were L. E. Fitzjarrald, Phillips Petroleum Co., Bartlesville, Okla., vice president for production; Henderson Supplee, Jr., president of The Atlantic Refining Co., vice president for transportation; Clarence H. Thayer, Sun Oil Co., Philadelphia, vice president for refining; C. J. Guzzo, Gulf Oil Corp., Pittsburgh, vice president for marketing, and W. J. Arnold, The Pure Oil Co., Chicago, vice president for finance and accounting.

P. C. Spencer, Sinclair Oil Corp., New York, and Willard M. Wilson, of the American Petroleum Institute, New York, were re-elected treasurer and secretary, respectively.

R. E. Foss, senior vice president of Sunray Mid-Continent Oil Co., Tulsa, was appointed chairman of the Executive Committee on Standardization of Oilfield Equipment and Materials of API's Division of Production. He succeeds H. W. Ladd, Pan American Petroleum Co., Tulsa, and R. W. McIlvain, Jr., vice president of

Plain Talk!

NUTEX
RING PACKED
PLUNGERS
TOUGH
ECONOMICAL
AND EFFICIENT

A TRUE STORY . . . . .

with a MONEY-MAKING MORAL

Recently the District Superintendent for a major oil company in the Gulf Coast of Texas quite frankly stated that he was not "sold" on composition ring pumps below 4,000 feet. However, he was broad-minded enough to test a composition ring pump in a well considerable deeper.

He has now converted completely to composition ring pumps.

LET'S LAY THE CARDS ON THE TABLE!

A composition ring pump won't work in every well . . . and neither will any metal to metal pump. It's a fact that if the composition ring pump will work, it will save a lot of money and it's also a fact that it won't cost but little to try a NUTEX. If it works . . . and the chances are good that it will . . . the savings on a lease basis will be very profitable.

With short ring plungers, depth capacity was limited. Some people still think of soft packed pumps as shallow pumpers — to approximately 4,000 feet. Today 120 ring and 160 ring NUTEX plungers are pumping successfully and regularly from 7900 to 8400 feet!

When the composition ring plunger is made the length of the metal plunger, the results are "PLAIN TALK" about *true* economy in pumping.

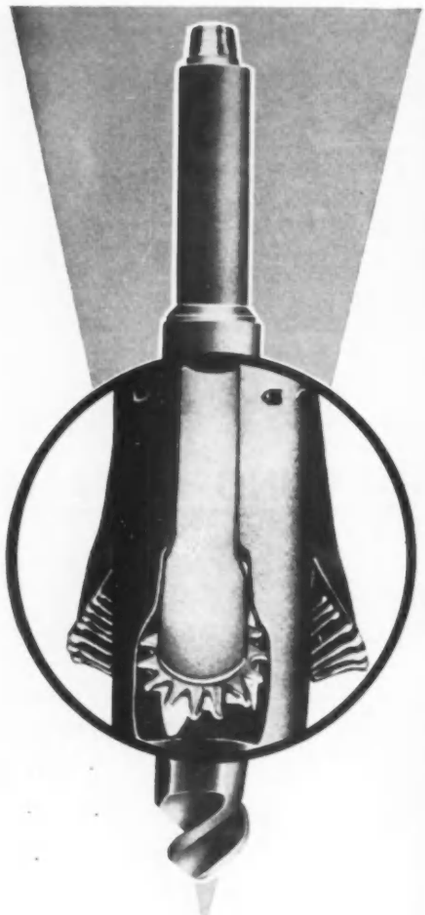
Investigate today! WHY NOT???

Available Thru All Supply Stores

OIL WELL PUMPING EQUIPMENT SINCE 1911
SUBSURFACE SPECIALISTS

BMW
BRADFORD MOTOR WORKS

BRADFORD MOTOR WORKS
Bradford, Pennsylvania
Tulsa, Oklahoma
Odessa, Texas



FOR EXPANDING SECTION MILLS AND HOLE OPENERS

LOCKOMATIC®

. . . is unequalled in safety, performance, and economy. There are a dozen reasons.

#2. The desirable well-bore shape (true cylinder) for landing liners and casing, gravel-packing, cementing, etc. is drilled by the shoulder-cutting roller cutters.

- SECTION MILL CUTTERS
- ROLLER CUTTERS
- DRAG CUTTERS

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serving the industry over 20 years

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VENTURA—MIller 3-4366, L & R Sales
HOUSTON—FAirfax 3-0854, Cassco Oil Tools
LAFAYETTE—CEnter 5-4031, Cassco Oil Tools
HOUMA—UPtown 9-2251, Cassco Oil Tools
MARACAIBO—7-9231, 7-9232, C.A. Std. Directional

Paul Andrews

C. R. Athy

G. E. Cannon

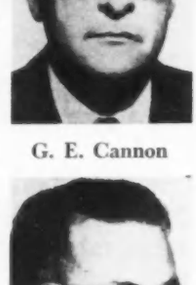
D. L. Connelly

Harold Denton

J. H. Field

The Pure Oil Co., Chicago, was appointed chairman of the division's Executive Committee on Training, succeeding Foss.

Alden S. Donnelly, a vice president of Honolulu Oil Co., chairman of the Committee on District Activities, and Jack Abernathy, president of Big Chief Drilling Co., chairman of the Executive Committee on Drilling and Production Practice, will continue in office.



W. S. Morris

Herman P. Pressler, director of crude oil marketing and public relations for Humble Oil & Refining Co., and Richard J. Farrell, associate general counsel of Standard Oil Co. (Indiana), Chicago, were appointed members of the Committee on Public Affairs. Pressler succeeds Morgan J. Davis of Humble, and Farrell succeeds Sunderland.

Speakers included Rep. Oren Harris (D-Ark.); Paul W. McCracken, professor of Business Conditions at the University of Michigan; O. A. Pipkin of Cities Service Oil Co., Ponca City, Okla.; T. L. Smith, head of the Supersonic Wind Tunnels Laboratory, Aberdeen Proving Ground, Md.; R. B. Jacobs, manager of Engineering Research, Standard Oil Co. (Indiana), Whiting, Ind., and Darwin W. Schmitt, engineer in charge of Turbo-Blower Department, Ingersoll-Rand Co., Phillipsburg, N. J.; Joe T. Dickerson; J. M. Patterson, director of public relations, American Oil Co., New York; Robert H. Scholl, vice president of Esso Standard Oil Co., New York; W. R. Huber, centennial director

CUT LOGGING COST! WITH THE PORTABLE *Geo-Logger*

The Geo-Logger is a portable one-man operated unit that goes everywhere. It is designed to record several different type logs. The field proven models range from 750' to 6000'.

FOR THE FOLLOWING PROGRAMS:

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- Geophysical
- Gas Storage
- Core Drilling
- Production Drilling
- Workover

TYPE OF LOGGING AVAILABLE:

- Electric (S.P. & Res.)
- Gamma
- Collar
- Temperature
- Caliper
- Interface Logging

Available in any combination for standard equipment or custom development.

WELL RECONNAISSANCE, INC.

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BOX 1483 DALLAS, TEXAS
FLeetwood 7-7378

for API, and John H. Williams, commissioner of the U. S. Atomic Energy Commission, Washington, D. C.

For contributions to the industry, the following men were awarded Certificates of Appreciation: Medical Advisory Committe, B. B. Reeve, M.D., Standard Oil Co. (Indiana), Chicago; Fundamental Research, Robert E. Loeck (posthumous), California Research Corp., La Habra, Calif., and John E. Sherborne, Union Oil Co. of California, Brea, Calif.

Committee on Petroleum Statistics, E. T. Knight (retired), formerly with The Atlantic Refining Co., Philadelphia, and E. F. Perkins (retired), formerly with Gulf Oil Corp., Pittsburgh.

Committee on Petroleum Reserves, D. V. Carter, Mobil Oil Co., Dallas, and Frank R. Clark (retired), formerly with The Ohio Oil Co., Tulsa.

Committee on Public Affairs, Joe T. Dickerson, Shell Pipe Line Corp., Houston and Thomas E. Sunderland, Standard Oil Co. (Indiana), Chicago.

Division of Production, Paul Andrews, Signal Oil and Gas Corp., Los Angeles; C. R. Athy, Ideco, Inc., Beaumont, Texas; George E. Cannon, Humble Oil & Refining Co., Houston; D. L. Connelly, Warren Petroleum Corp., Houston; Harold Denton, Sun Oil Co., Beaumont; J. H. Field, Sohio Petroleum Co., Oklahoma City, and W. S. Morris, East Texas Salt Water Disposal Co., Kilgore.

T. O. Hall of Houston Elected SEG President

Thomas O. Hall, president of General Geophysical Company, Houston, was named president of the Society of Exploration Geophysicists at its Twenty-Ninth Annual International Meeting in Los Angeles.

Other officers installed were: Frank Searcy, Continental Oil Co., Ponca City, Okla., first vice president; Dean Walling, president of Western Geophysical Co., Los Angeles, vice president, and Phil P. Gaby, Delta Exploration Company, Jackson, Miss., secretary-treasurer. Hall succeeds E. V. McCollum of Tulsa.

Advanced Drilling Course Offered at Texas A. & M.

The Petroleum Engineering Department of the A&M College of Texas has completed plans to offer an Advanced Drilling Engineering Course for Petroleum Industry personnel. The course is also sponsored by the American Association of Oilwell Drilling Contractors which has made a grant of $2,500 to the department for the purpose of assisting in instituting the course.

Two identical sessions of the course will be held January 4-15, and April 25-May 6, 1960. The sessions will be held in the Memorial Student Center on the campus and will consist of both lectures and supervised computation, approximating 80 hours of instruction. The lecturers for the course will be selected specialists from industry and members of the Petroleum Faculty.

Anyone desiring further information should contact Robert L. Whiting, head of the department, College Station, Texas.

Gladys Watford Chosen 1960 President of ADDC

Miss Gladys Watford of Houston was chosen president for 1960 by the Association of Desk & Derrick Club members at the association's meeting in San Antonio. Miss Watford is secretary to Ralph A. Johnston, an independent oil man of Houston.

New handling ease with Diamond Caustic Soda in BAGS

Diamond Flake Caustic Soda is now available in tough, 50- and 100-lb. bags, *more airtight than steel drums.* In tests, these bags were submerged in water for days without affecting the contents. This is made possible by using a separate, heat-sealed, polyethylene inner bag, protected by an extra strong, kraft and fibre outer bag. These bags save you money, too, because we pass *our* packaging and handling savings on to *you.*

EASY HANDLING . . .

No strain to lift or pour, easy to load and move. Thousands shipped without a single instance of bag failure.

EASY STORING . . .

Store inside or out, easy to stack, takes 50% less space than drums.

EASY DISPOSAL . . .

Just burn or bury the empty bags. Nothing to haul away.

For the names of your nearest suppliers call or write DIAMOND ALKALI COMPANY · 1006 Main Street · Houston 2, Texas

Diamond Chemicals

FOR

9,000-FOOT SERVICING

WICHTEX Model F-75-Heavy-Duty . . . truck or trailer mounted . . . is recommended to 9,000 feet with an 87-foot or 65-foot fabricated telescoping derrick, or double telescoping 65′ x 7″ x 8″ mast, or double telescoping 87′ x 8″ x 10″ mast. Equipped with air friction clutches, air or hydraulic friction cathead, and optional winch mounted to raise mast.

Wichtex Servicing Units range from 2,000′ to 12,000′ capacity —spudding attachment optional.

WICHTEX WELL SERVICING UNITS

WICHTEX MACHINERY COMPANY

P. O. Box 2250
WICHITA FALLS, TEXAS

Also Manufacturers of
WICHTEX PORTABLE ROTARY RIGS
2,000′ to 5,000′ capacity

What's Happening among SERVICE and SUPPLY MEN

R. A. Forsman

C. D. Crickmer

Baash-Ross Division of the **Joy Manufacturing Company** has named **Robert A. Forsman** director of sales and service. At the same time, **Charles D. Crickmer** joined Baash-Ross as assistant engineer in charge of engineering activities.

Harold Brown Company has named **B. O. (Pat) Childs** West Coast distributor for the firm's line of gas lift equipment. The West Coast operation will be known as **Harold Brown Company** of California with headquarters in Ventura, Calif.

Worthington Corporation has had a major organizational change at its Buffalo, N.Y., Compressor and Engine Division. Engine Sales Department has become two separate groups: Power Engine Sales and Engine Compressor Sales, both reporting to **E. A. Murray**, manager of Sales and Service. **Alfred M. Boehm** was appointed manager of Power Engine Sales and **Howard C. Barten** became manager of Engine Compressor Sales.

Auto Crane Company has named **W. H. Esser** vice president of the firm. Esser formerly was transportation manager for Shell Oil Company.

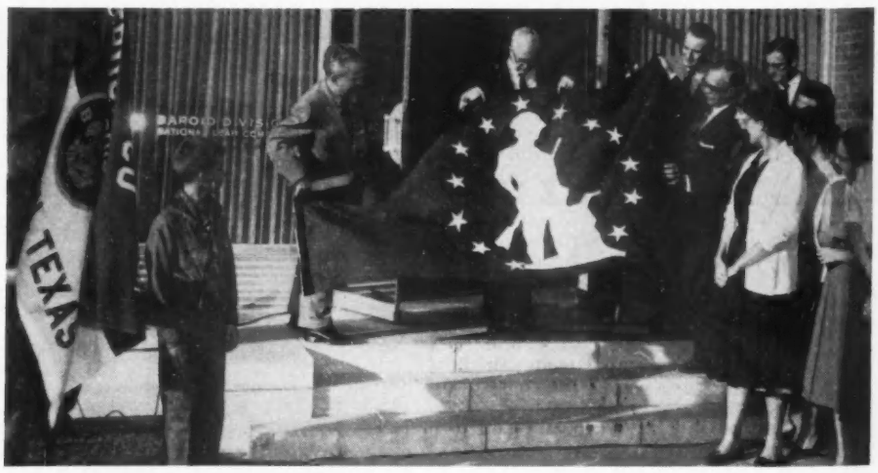
Robert L. Butler has been appointed chief accountant of **Dayton Industrial Products Co.**, a division of **Dayton Rubber Company.** Butler was formerly with Appleton Electric Co.

R. W. (Cliff) Clifford has joined the sales force of **W. C. Norris, Manufacturer, Division of Dover Corporation.** Clifford has been assigned to the West Texas Sales Division and will be headquartered in Midland, Texas.

P. L. Myers

Hughes Tool Company has promoted **Park L. Myers** to the position of assistant vice president—sales. For the past four years Myers has been domestic sales manager, responsible for the company's sales in the United States and Canada. Myers succeeds **W. H. Siems,** who was named vice president in charge of sales.

Oil Base, Inc. has appointed **Wm. Cameron & Company** a distributor for No-Glo Oil and No-Glo Thread Lubricant in West Texas, East Texas, and Four Corners areas.

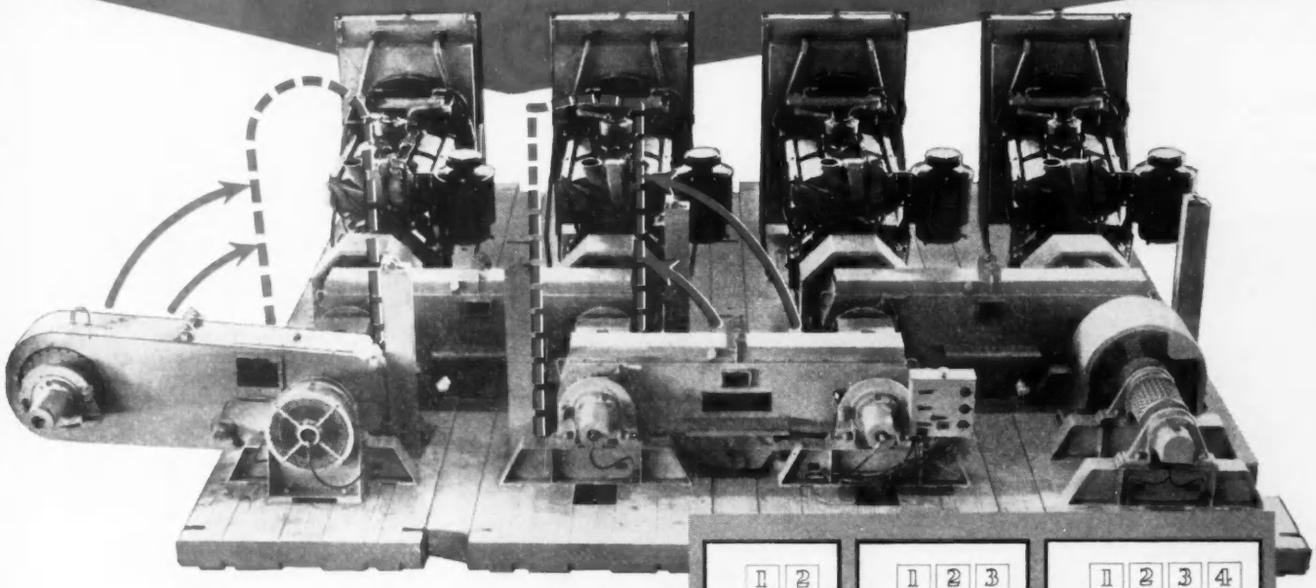


Baroid Receives Treasury Award

In a ceremony conducted at the Baroid Division National Lead Company general offices in Houston, the United States Treasury presented the Treasury Department's honor flag to Baroid for its support of the current savings bond drive. J. W. Hofstetter (left), assistant general manager of Baroid; S. C. Bray (center), regional director of the Savings Bond Division, U.S. Treasury Department; Harry Dedeaux, Savings Bonds representative (behind flag); W. W. Louden, assistant general sales manager of Baroid (holding flag at right) and Baroid Comptroller H. H. Heath (far right), examine the Minute Man Honor Flag presented Baroid for 90 percent or better employe participation in the Savings Bond drive. Baroid was the first industrial company in Texas to receive this award since World War II. Hofstetter was accompanied by an honor color guard made up of Boy Scouts who are sons of Baroid employes.

*Swinging Compounds**

key to fast moves . . . quick rig-up!



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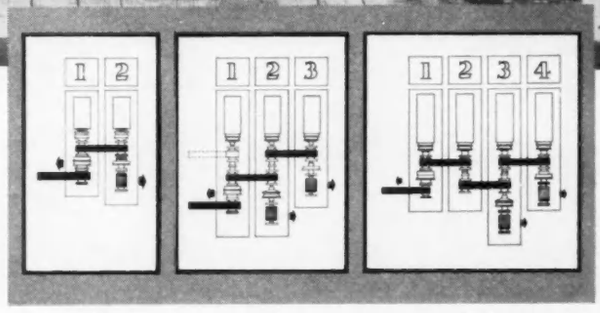
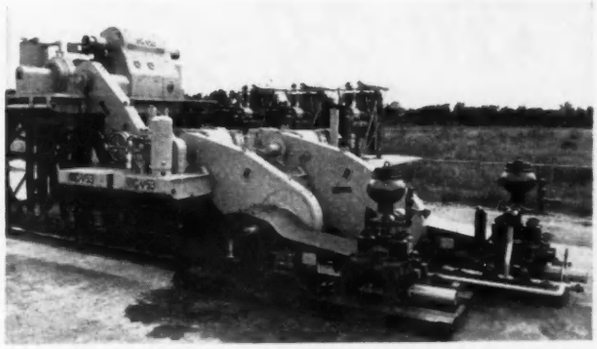


2AE 3AE 4AE

an exclusive feature on
MID-CONTINENT AE RIG DRIVES

The Mid-Continent AE Rig Drive is a development of the Swinging Compound, a patented Mid-Continent feature. Swinging Compounds simplify the addition of engines, and makes possible moves without opening compound cases, draining oil, or "breaking" chains. Simply by pivoting Swinging Compounds to a vertical locked position, the units are ready to move to the next location. Designed for two, three, or four engines totaling 800 to 2400 horsepower, all compound case assemblies are identical for any combination. There is an AE Rig Drive to match your drilling requirements. Contact your Mid-Continent representative for complete information.



Scheduled for shipment to Argentina, this rig is equipped with a Mid-Continent 3AE Rig Drive including Swinging Final Drive, and Swinging Pump Drives for the maximum in flexibility and quick rig-up.

RD1-9

MID-CONTINENT SUPPLY CO.

MID-CONTINENT BUILDING • FORT WORTH, TEXAS

Export Division: 45 Rockefeller Plaza, New York 20, N. Y. Cable: MIDCUMPORT NYK

THE WORLD'S LARGEST INDEPENDENT OIL FIELD SUPPLY COMPANY

M. Les Barr

M. Les Barr has been named sales engineer of the East Texas and Texas Gulf Coast areas for **Edward Valves, Inc.**, sudsidiary of **Rockwell Manufacturing Company.** Barr will represent the company's line of cast and forged valves in the power, industrial and petroleum fields. He was formerly associated with The National Supply Company.

John C. Madden has been appointed sales manager, oil country tubular products, for **The National Supply Company.** He succeeds **W. R. Ryburn** who has resigned.

Rhein Benninghoven has been named sales representative for the Kansas-Missouri-Nebraska area for **Edward Valves, Inc.** Benninghoven, district sales manager for **Republic Flow Meters Co.**, will continue in that capacity. The announcement was made by **W. F. Crawford**, president of Edward Valves and Republic Flow Meters, both subsidiaries of Rockwell Manufacturing Company.

Treat-Rite Water Laboratories, Inc., has appointed **J. P. (Jack) Powell** manager of the Engineering Department. Powell was formerly engineer for the U.S. Bureau of Mines, Bartlesville, Okla.

J. D. Gladden has been named sales manager of the new Southwest Region of **International Harvester Company's** Construction Equipment Division. Gladden was assistant manager of the Plains Region. In his new role, he will handle Missouri, Kansas, Oklahoma, Texas, New Mexico, and three counties in Arizona.

W. E. Teague

Winston E. Teague has been appointed southwest manager of oil field sales with headquarters at Dallas, for **Chain Belt Company.** Teague joined Chain Belt at its San Francisco office in 1950 where he served on the order desk and later as a sales engineer. In 1955 he moved to the Los Angeles office and continued in a sales engineering capacity.

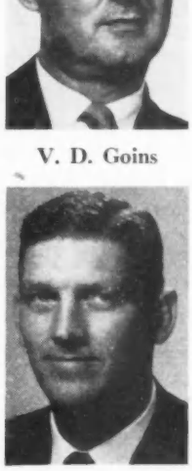
R. J. Rice, assistant division manager, Logging and Sales Promotion, **McCullough Tool Company**, will be in charge of the new Mountain Division sales office recently opened in Billings, Mont.

P. V. Edwards, formerly district sales manager at Edmonton, Alta, has been named regional manager for **Jones & Laughlin Supply Division's** Canadian sales force, with offices in Calgary. **R. J. Phibbs**, formerly salesman at Calgary, has become city sales manager at Calgary, and **S. D. Martin**, formerly salesman at Calgary, has been promoted to district sales manager at Edmonton.

U.S. Steel's Oil Well Supply Division has appointed **A. L. Crenshaw** field representative at Laurel, Miss. Also, **F. L. Akers** was appointed district representative at Borger, Texas. **Bruce L. Rhea** and **D. W. McManus** were appointed field representatives at Graham, Texas, and Houma, La., respectively.

V. D. Goins

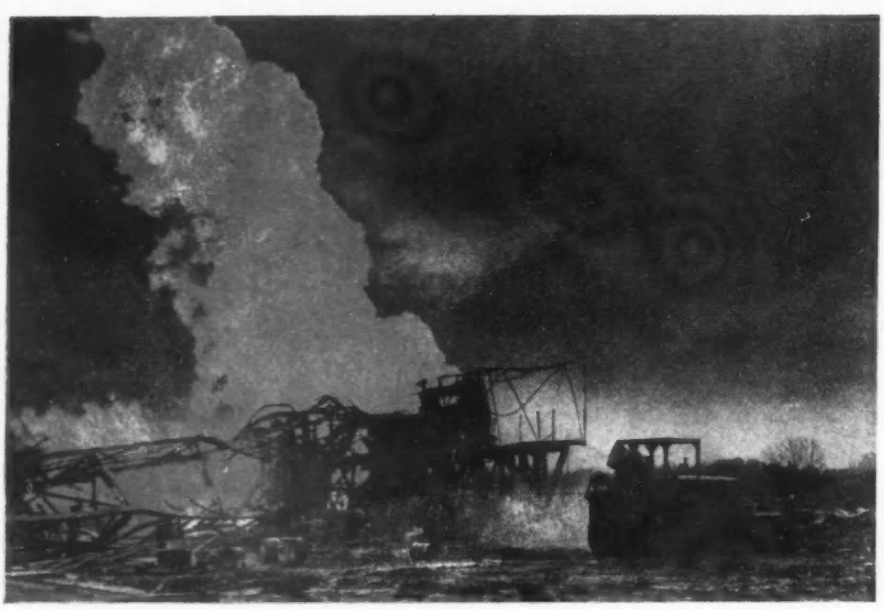
A. B. Roop



A. J. Murski

Tuboscope Company has promoted three men in their organization. **A. B. Roop** has been named vice president and general manager. **Vernon D. Goins** has been named vice president in charge of operations; and **Albin J. Murski** has been named Southwest Zone manager.

Charles E. (Preacher) Myers has joined **Shot Point Service, Inc.**, as vice president and general manager. A new geophysical company, Shot Point is engaged in contract for seismograph operations in Texas, Mississippi and Florida. Home office for the new firm is located in Houston.



A "Pit-O-Graf" MIGHT HAVE SAVED THIS WELL

A Pit-O-Graf can give adequate warning to prevent a blowout. But, it must be where the driller can see it, can take advantage of it. Here's what users have to say:

One oil company says — "Although blowout prevention is a matter of concern for the operator, the contractor, and the drilling crews, generally *the driller is the key man.*"

Another company says—"Since a pit level indicator is so important, take these precautions to get the most good out of it: Place the pit level recording instrument at or near *the driller's position on the derrick floor.*"

If the driller's responsibility is not misplaced, then he can recognize the danger signals that precede every blowout. With the Pit-O-Graf record before him, he can intelligently analyze the *rate* of gain or loss of mud as recorded and thereby direct his crew in the orderly control of the situation at hand. In this case the threatened blowout would become *one that does not happen.*

WARREN AUTOMATIC TOOL CO. HOUSTON — W A TCO C O

WARREN AUTOMATIC TOOL CO.

3915 THARP STREET • HOUSTON, TEXAS

Phone CApitol 4-2511

Lake Charles HEmlock 6-2265 | New Iberia EMerson 9-9862 | Harvey FOrest 6-1441

E. J. Davis

J. Sutherlin

Dowell Division of **The Dow Chemical Company** has transferred two district managers for Denver and Houston districts. **Earl J. Davis,** formerly district manager at Denver, has been named manager of Dowell's Houston District, replacing **Jack Talbot** who has transferred to the Company's Industrial Operations in Cleveland. **Jack Sutherlin,** formerly district manager at Wichita Falls, Texas, has replaced Davis at Denver. **W. B. (Silver) Harley** will continue as area manager of the former eastern area of Wichita Falls district. **H. D. (Doug) Woodard** will continue as area sales manager. **Eddie Ernst** is now district engineer for the eastern area.

J. A. Lineham, salesman for **Jones & Laughlin Supply Company** Division at Stettler, Alta., Canada, has been assigned to Whitecourt, Alta.

The Parkersburg Rig & Reel Company has appointed **Howard C. Taylor** product manager of Hydromatic Brake Hydrotarder sales.

Avery Brown has joined **Drilling Analysis Service Company,** an affiliate of **E. A. Polumbus, Jr., & Associates.** He will represent DASCO in sales with headquarters in Denver.

John H. Shelton

Dale Williams

Jack Williams

John H. Shelton replaces **L. S. (Spider) Allen** as head of the Armco Surface Casing Division of **National Tank Company.** Assisting Shelton will be **Dale Williams** as Tulsa Salesman. **Jack Williams,** engineer and branch manager, Odessa, replaces Shelton as West Texas manager.

Jack W. Roff, former district sales manager for McEvoy Company has joined **Southwest Supply Company** as special representative. Roff is based in Houston and will serve North and East Texas and the Gulf Coast areas.

NEW WELL LOGGING PACKAGE CUTS COSTS... PROVIDES EXTRA INFORMATION

HYCALOG

CONTINUING RESEARCH FOR LOWER COST EXPLORATION

Continuous chromatographic monitoring and analysis of gas shows . . . *along with recording of principal drilling functions* . . . are combined in Hycalog's new GR-FDR package. And automatic operation permits the use of this equipment with *only one* attendant.

The package includes *two complete recording networks* . . . HYCALOG GAS CHRONOFRAC and a hot wire detector. One monitors methane content of mud gas samples and analyzes shows; the other records total combustible gases.

Added to this is the MARTIN-DECKER recording network which automatically measures and records the following drilling functions: weight on bit, pit level, pump pressure, and pump speed. (Recording of other functions such as torque and rotary speed are optional).

A *single* operator compiles and forwards daily all recorded data along with the log of any shows encountered.

With the new GR-FDR package you are sure of getting *round-the-clock* information at a cost far below regular well logging service.

Write for facts on the GR-FDR package. *And, while you're at it, ask about* HYCALOG V-DOOR *diamond drill bits.*

Hycalog, Inc.

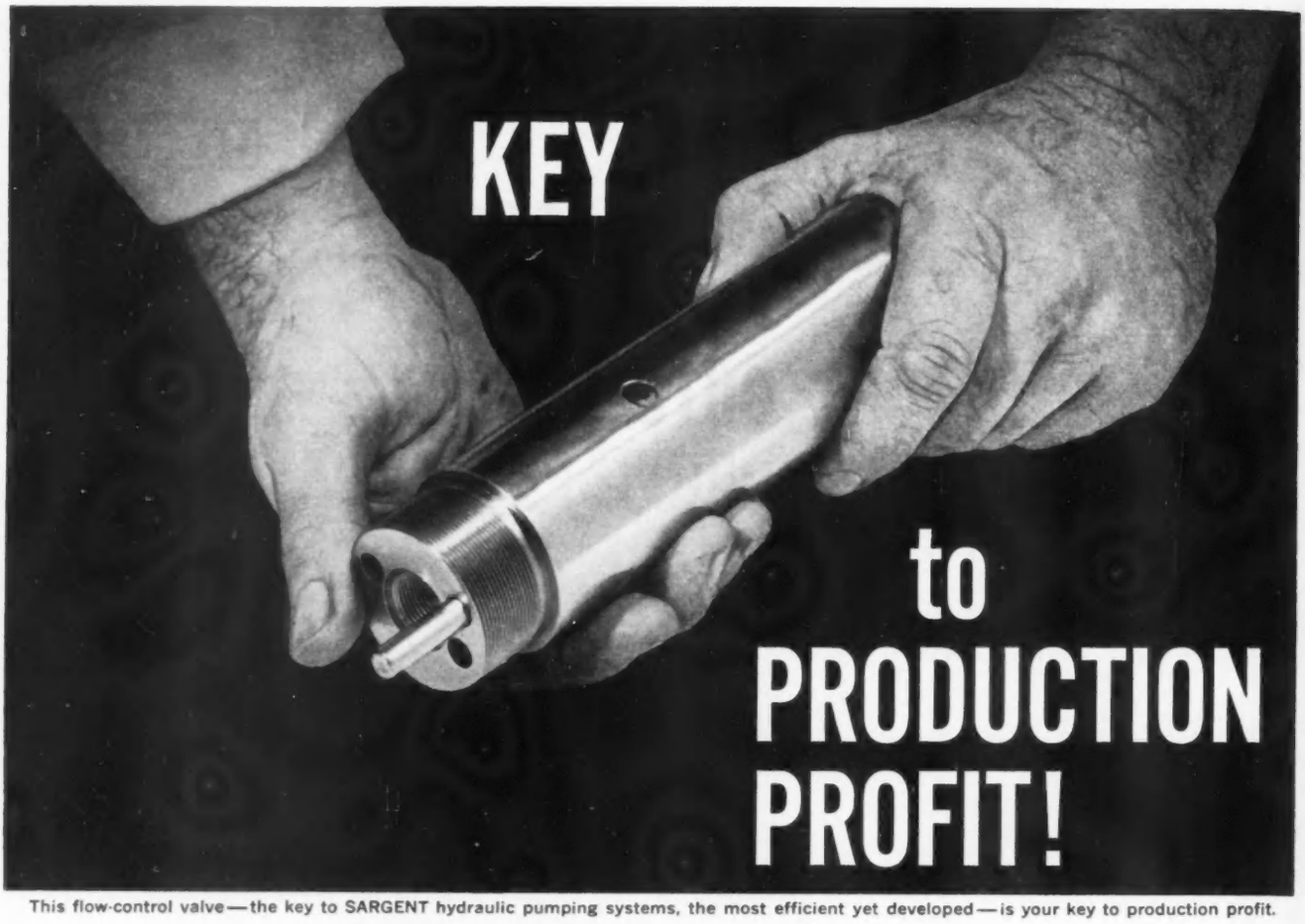
505 AERO DRIVE

SHREVEPORT, LOUISIANA

BRANCH OFFICES IN PRINCIPAL OIL PRODUCING AREAS

DIAMOND CORING • DIAMOND BITS • WELL LOGGING • CORE ANALYSIS

For more data on advertised products, use Readers' Service Cards, last page.



This flow-control valve—the key to SARGENT hydraulic pumping systems, the most efficient yet developed—is your key to production profit.

PROFIT = PRODUCTION – (Installation & Maintenance)

When SARGENT took the long stroke unit from the TOP of the hole and placed it at the BOTTOM to operate the time-proved standard bottom-hole pump, things happened!

UNDER THE TOUGHEST FIELD CONDITIONS

WITH THE SARGENT FREE TYPE PUMP:

1. Sucker rods are eliminated, along with the cost of rod replacement and tubing wear.
2. Maintenance costs drop. No longer a need for costly crew time or expensive pulling equipment.
3. Maximum effective long, bottom-hole stroke is made possible by the exclusive SARGENT design which provides positive plunger travel with pre-set valve spacing.
4. Unrestricted application because the pump can be used on any well or on more than one well in group operations.
5. This pump has been operated on oil, salt water or fresh water as power fluid.

"MISSILE QUALITY" PUMPS

"Missile Quality" represents the uncompromising excellence of product engineering and manufacture where "almost perfect" is not good enough. Years of experience in the design and production of missile, aircraft and marine components enables SARGENT to produce "missile quality" A.P.I. classified pumps in advanced metals and designs to meet any well condition – your assurance of better pump performance.

If you are interested in "production for profit" use SARGENT.
Talk to your SARGENT Representative and learn how profits can be boosted by lowered "Installation-Maintenance" costs.

SALES AND SERVICE

CALIFORNIA	OKLAHOMA	TEXAS	ILLINOIS
Long Beach	Oklahoma City*	Odessa	Grayville
Bakersfield	Ratliff City	Snyder	**ARKANSAS**
Ventura	Pawhuska	Andrews	Magnolia
Taft	Seminole	Midland*	**KANSAS**
Huntington Park	**NEW MEXICO**	Sundown	Chase
Santa Fe Springs	Farmington	Wichita Falls	Russell
	Hobbs		Great Bend*
	COLORADO		
	Rangely		

*Sales Representation

"GOOD WILL" is the disposition of the pleased customer to return to the place where he has been well treated.– U. S. Supreme Court

Sargent
INTEGRITY BUILDS GOOD WILL

Standard of Excellence Since 1920

ENGINEERING CORPORATION

MAIN OFFICE & PLANT • 2533 E. FIFTY-SIXTH ST.
HUNTINGTON PARK, CALIF.

Johnston Testers, Inc., has announced a number of promotions and reassignments with the sales division.

B. J. Graham

B. J. Graham has been promoted to manager of the Marketing Division. He will supervise export and domestic products sales. **P. H. Griffin,** senior sales engineer in the Fort Worth-Dallas area, has been assigned to the Southern Division office. **F. L. Rippetoe,** Southern Division salesman, has transferred to Midland, Texas, as a salesman. Newly hired engineers are **J. R. Holmes** and **G. E. Wilson. H. R. Walters,** tester in Riverton, Wyo., is now district manager at Riverton. **D. B. Ledbetter** has been promoted from tester at Kimball, Neb., to district manager at Vernal, Utah. **E. B. White** is now manager of supply in Houston.

United States Steel Corporation has elected **William H. Lang** administrative vice president and treasurer to succeed **Howard E. Isham,** who has retired.

L. P. Normand is the new manager of **Gulf Coast Machine & Supply Company's** CTP Automatic Chock Division, with headquarters in Beaumont, Texas.

C. S. Smith

G. N. Jones

Jones & Laughlin Supply Division has made three changes in the field sales force. **G. N. Jones,** salesman at Williston, N. D., has transferred to Glendive, Mont. **W. R. Woodward,** salesman at Wichita, Kan., has been assigned to New Orleans. **C. S. Smith,** sales trainee at Shreveport, La., has been promoted to salesman and assigned to Odessa, Tex.

W. R. Woodward

Donald E. Barber has been named product engineer in charge of the electrical section of the large excavator division of **Bucyrus-Erie Company. William P. Schlecht** is the new project engineer in charge of crane carriers and hoe front ends in the commercial crane and excavator division.

Bethlehem Steel Corporation has made the following promotions in its Tulsa plant. **A. T. Hunt** appointed chief engineer succeeding **H. E. Davidson,** deceased. **P. H. Jezzard** appointed machinery application engineer and **R. J. Oliphant** appointed supervisor of the Production Control Department.

Published November 1959

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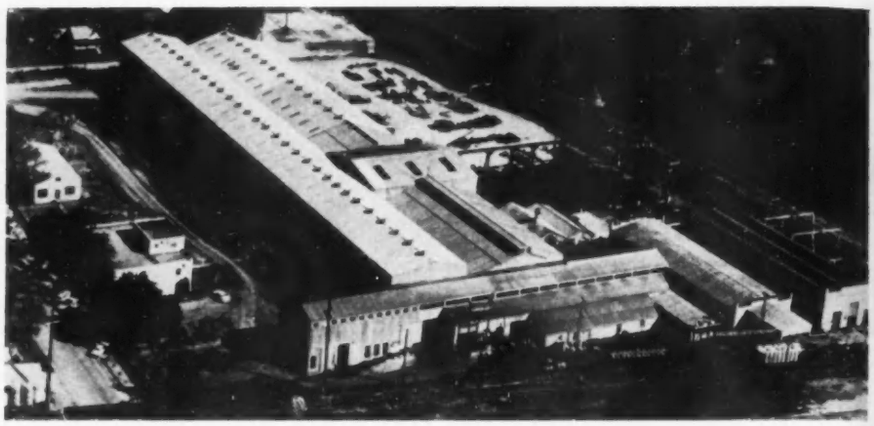


Parkersburg Shows Off New Kansas Plant

A million-dollar expansion of their oil field manufacturing plant at Coffeyville, Kan., has been completed by The Parkersburg Rig & Reel Company. The new plant includes two new buildings providing an additional 60,000 square feet of manufacturing space, an automotive-type assembly line for final assembly of oil field pumping units, drive-through dock facilities, permitting multiple loading of trucks, and enlarged outdoor storage facilities. The Coffeyville plant operations are under the direction of Plant Manager Jess Kern.

Kenneth R. Lord has been promoted to division sales manager for the Edmonton, Alta, division of **Hughes Tool Service, Ltd.** Lord replaces **D. W. Potts**, who has transferred to Calgary as division sales manager.

Empire Geophysical, Inc., has promoted **Robert G. McCuistion**, Seismic party chief, to supervisor. He will work out of Empire's Midland, Texas, Regional office.

E. A. Martin, London manager of **Padley & Venables, Ltd.**, was recently promoted to the position of London Director.

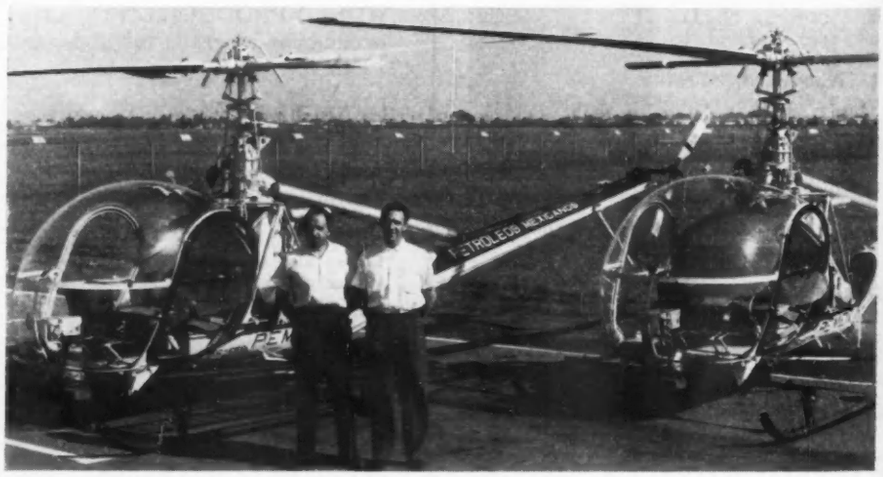
Schlumberger Well Surveying Corporation has assigned **R. K. Thies** to the Texas Gulf Coast Division office where he will serve as senior sales engineer.

E. Van Raalte has been appointed to the position of company general manager of **Robin-Nodwell Manufacturing Limited**, Calgary. As general manager, Van Raalte will serve on the Board of Directors which now includes: **Carl O. Nickle**, Calgary oil man **A. G. Bailey**, vice president and general manager of Bailey Selburn Oil & Gas Ltd.; and **F. Gordon Elves**, president of F. Gordon Elves Investments, Ltd.

ACF Industries, Inc., has elected **Cole H. Pilcher** vice president for industrial relations. Pilcher was formerly with Sylvania Electric Products, Inc.

G. & J. Weir Ltd., London, has been licensed to manufacture a complete line of reciprocating and centrifugal compressors designed and made by **Clark Bros., Co.**, One of the **Dresser Industries. J. Russell Lang** is the managing director of the Weir company, and **Michael J. Galpin** is the director of European operations, both are headquartered in London.

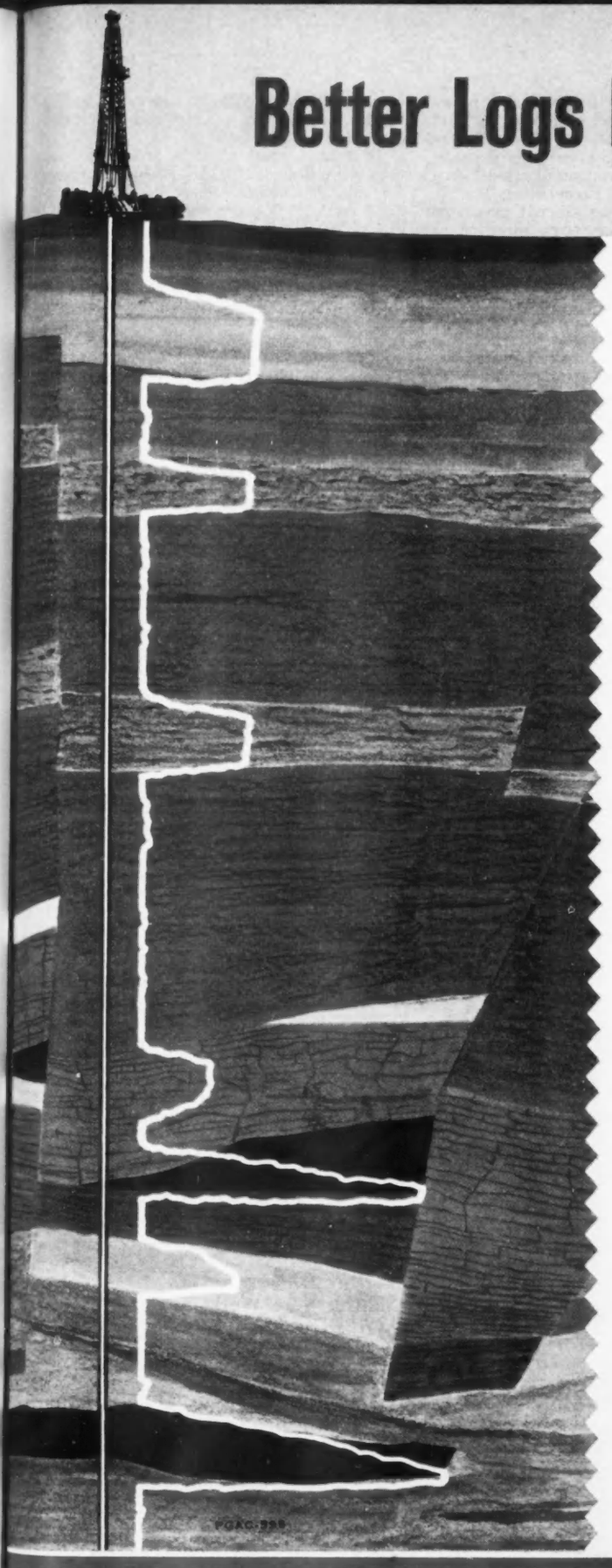
Henry Franks has been appointed district sales manager for **Jones & Laughlin Supply** Division's Central Rocky Mountain District at Casper, Wyo. Also, **W. J. Chisholm**, salesman at Edmonton, Alta., has been transferred to Calgary, Alta. **R. E. Haulk**, store manager at Harvey, La., has been assigned as salesman in the division's New Orleans office.



Hiller 12Es Delivered to PEMEX

Captain Alberto Gay'on (left) and Captain Luis Salinas, pilots for Petroleos Mexicanos (PEMEX) are shown with their new Hiller 12E helicopters prior to their long delivery flight from the Hiller Palo Alto plant to PEMEX headquarters in Mexico City. The helicopters are part of a program to modernize and expand PEMEX's vast petroleum operations throughout Mexico.

Better Logs Make Better Wells...



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John W. Davis has been appointed export manager of **Mid-Continent Supply Company.** Davis who was Venezuelan manager before being named export manager, will return to New York to direct the activities of the Export Division from its headquarters there. He had become assistant export manager in New York before his move to Caracas, Venezuela, as Venezuelan manager.

John W. Davis

Craig M. Rowley has been elected president of **The Parkersburg Rig & Reel Company, Division of the Parkersburg-Aetna Corporation.** Rowley previously served as executive vice president and general manager of The Parkersburg Rig & Reel Company. He was elected president at the Board of Directors meeting of Parkersburg-Aetna Corporation which was held in Chicago recently.

Walworth Co. and Canada Iron Foundries Unite in New Operations

The Walworth Company has united for an exclusive licensing arrangement with Canada Iron Foundries, Ltd., for the manufacture and sale in Canada of the Walworth industrial line of valves including bronze, iron, steel, plastic and lubricated plug valves.

In recent years Canada Iron has handled a limited number of Walworth valves for sale in Canada.

Crane Company Acquires Assets Of Chapman Valve Company

Crane Company of Chicago recently acquired by purchase all properties and assets of The Chapman Valve Manufacturing Company. The sale price of $11,197,377 was approximately book value. Proceeds will be paid to Chapman stockholders promptly.

The plant, located in Indian Orchard (Springfield), Mass., to be known as The Chapman Valve Manufacturing Company, is a wholly-owned subsidiary of Crane. It will retain its present management and executive staff, headed by C. Goodwin Carter.

Tretolite Starts Construction For New Chemical Facility

The Tretolite Company of California, Division of Petrolite Corporation, formerly broke ground recently for its complete new $2 million chemical manufacturing facility at Brea, Calif.

Completion of the new construction is expected before mid-1960, at which time the company will move from its present offices and manufacturing plant in Los Angeles. The new Brea facility will include an administration building, three laboratory buildings, and complete, highly automated manufacturing facilities. At present, only approximately 10 acres of the 23-acre site will be utilized, the remainder being retained for future expansion.

Woodfield Pickering Ltd. Is Newly Formed Company in England

The newly formed company of Woodfield Pickering Ltd., is designed to serve those engaged on offshore continental shelf drilling and marine servicing operations.

Based on the accepted American designs of drilling rigs and marine hydraulic spud jacking, and directed by experts in these particular fields, this new company offers the combined services of shipbuilding, heavy engineering including hydraulics and the manufacture of drilling equipment together with deck machinery.

Woodfield Pickering, Ltd., has offices in London, Netherton Road, Wishaw and Lanarkshire.

Shaffer Tool Works Completes Marketing Plans With S.N. MAREP

Shaffer Tool Works has announced completion of a manufacturing and marketing agreement with the Societe Nationale de Materiel Pour La Recherche et L' Exploitation du Petrole (S.N. MAREP), whereby the S. N. MAREP organization is licensed to make, use, rent and sell certain Shaffer well completion products throughout France, its territories, and major areas of Europe.

The products to be handled by S. N. MAREP include Shaffer casing heads, Shaffer tubing heads and Shaffer well heads, as well as Shaffer flow beans, Christmas trees and related equipment. In addition to France and its territories, the agreement permits S. N. MAREP to make, use, rent and sell the Shaffer products in all countries belonging to the European Common Market, including Morocco and Tunisia.

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1. UNIVERSAL TREATING COMPOUND . . . successfully treated different types of emulsified conditions in all areas tested.
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at 100 rpm to 6,200 feet with 2⅞", 3,800 feet with 4½" drill pipe. . . . Perfect for drilling relatively shallow oil wells, the deepest of water wells, workover rigs and slim hole drilling!

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For more data on advertised products, use Readers' Service Cards, last page.

SPECIFY

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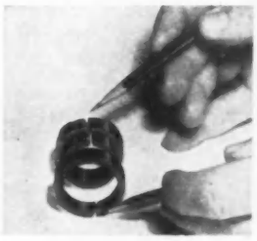
Flex-Seal

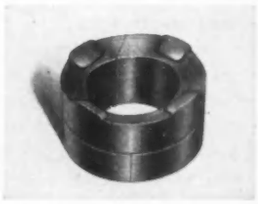
DOWN-HOLE PUMP PLUNGERS

Now with NYLON rings for 1-1/4, 1-1/2, 1-3/4 and 2" insert pumps and 1-25/32" common working barrels.

- INCREASE PRODUCTION
- REDUCE SANDING-UP
- INCREASE LIFE OF BARRELS
- REDUCE SERVICING
- REDUCE STOCK (Valve Cups) to ½ Your Former Stock
- REDUCE COSTS



Flex-Seal ring is actually two-rings-in-one. They have been separated here to show split construction as a mated pair.



Assembled Flex-Seal ring shows patented, offset bevels which permit flushing of gas and sand during the free stroke of the plunger or barrel.

Because of their unique construction, Flex-Seal rings expand to the bore of the barrel during pumping stroke for maximum production efficiency. Damaging metal-to-metal contact is eliminated. *Write for literature and prices.*

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"New Rule—All Foremen Gotta Wear Ties."

Famous Last Words

"Darling this cake is simply delicious. Tell me. Did you buy it yourself?"

Too Big—Too Late

Have you heard the one about the maternity shop which received the following letter: "Please cancel my order for a size 42 dress. My delivery was faster than yours."

A Real Worry Wort

"You sure look worried."

"Man, I've got so many troubles that if anything happens to me today, it'll be at least two weeks before I can worry about it!"

The Golden Rule

An exasperated salesman abandoned his car in a parking zone, left this note: "I've circled this block 20 times. I have an appointment and must keep it or lose my job. Forgive us our trespasses." Upon returning he found a parking ticket and this note: "I've circled this block 20 years. If I don't give you a ticket, I'll lose my job. Lead us not into temptation."

TV or Not TV

The TV producer came rolling in one morning at 9 a.m. to face his very angry wife.

"The rehearsals lasted 'til midnight. Then I drove one of the chorus girls home and she asked me in for a nightcap. We had a few drinks and by that time it was so late that she asked me to stay all night. So I did."

"A likely story," said his wife angrily. "You've been out playing poker with the boys again."

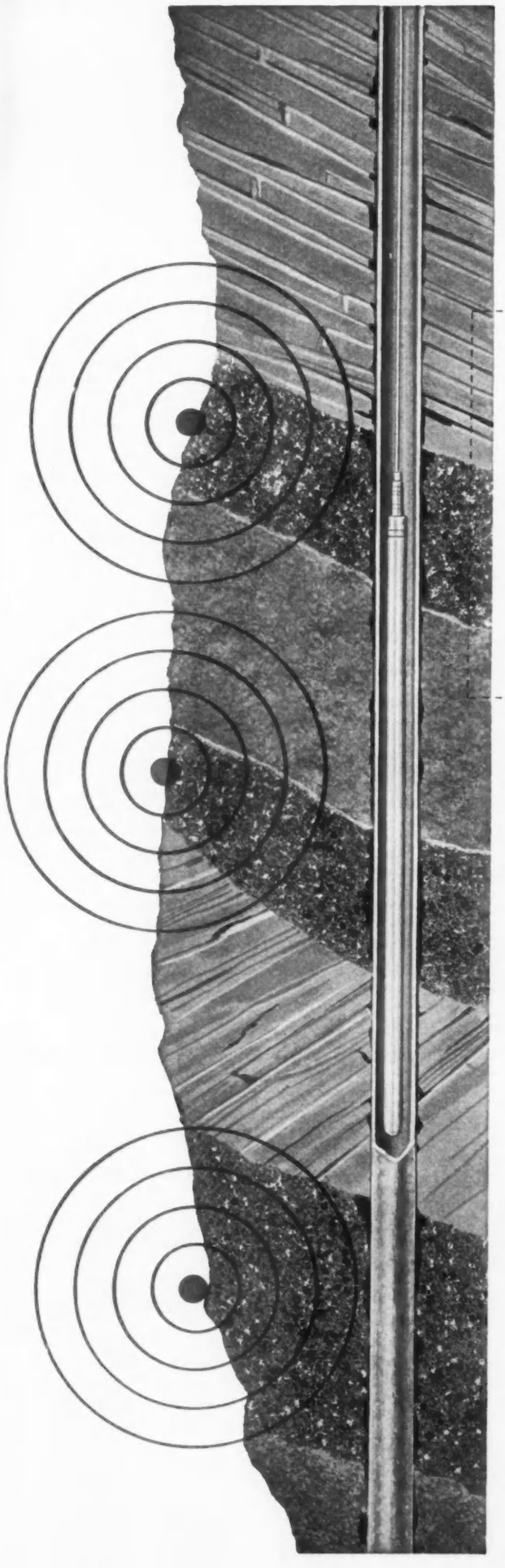
A Night to Remember

Wife at home after the party: "Here I buy a new evening gown, wear it for the first time and you say not a word; but you notice every other woman at the party, even those wearing last year's dresses."

"Well," he explained, "after you know what's in a package, the wrapping don't make much difference."

Our Modern Age

TV Commercial: "These wash-and-wear pajamas dry instantly, need no ironing. You can wash them at night and they'll be ready to put on in the morning."



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An electric log, run in this shallow Illinois oil well, proved of no value to the operator. Log curves were not detailed—thin sands were missed entirely.

McCullough's Radiation Well Logger was run, obtaining simultaneous Gamma Ray-Neutron Curves and a Collar Log. Thin sands were easily located from the detailed log. Correlation with core data was exact.

From precise logging depth measurements, the well was perforated with 54 shots—16 Ogival Bullets by an M-3 Gun and 38 Standard Casing Glass Jets.

Initial production was over 400 B/D—a fine well for the field. Rig time on the job was nine hours. Operator was very pleased with the accuracy and efficiency of McCullough operations.

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with Scintillation Detector

U. S. Patents 2,686,266; 2,686,268; others pending.
Patented in Great Britain, Australia, Venezuela, Mexico, Brazil; others pending.

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McCullough's Gamma Ray and Neutron Curves, recorded simultaneously with a Collar Log, give you clear, reliable formation information—precisely measure and define productive zones, thick or thin—assure you of more accurate quantitative analysis—correlate better with cores and electric logs.

And, when you perforate by McCullough's down-hole logging measurements, you're sure of "putting the shots where they count" with pin-point accuracy—fully and uniformly covering the pay zones; no more, no less.

For a better oil well, always log and perforate with McCullough.

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CLEAN OUT CHOKING SAND

Excessive sand and sediment holds back your oil. For fast, easy clean out with fewer round trips and less downtime, use world famous Miller Sand Pumps.

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O.D.—2½, 3, 3½, 4¼, 5, 5½, 7 in.
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Ye Ole College Spirit

While visiting his son at college, he was taken to a room that the son shared with his pal. There they found the pal, sitting at a desk with a note pinned to the back of his chair: "If you happen to come in and find me studying, please wake me up."

Logic

Did you ever notice how often a narrow mind and a wide mouth go together?

Eating Out Is Fun

Tipsy Truck Mechanic: "Shay, Joe, ish your wife a good cook?"

Tipsy Freight Loader: "Ish she a good cook? Listen, buddy, she's tha only one I know who c'n loush up corn flaksh."

It's Only Psychological

At the convention of psychiatrists a woman delegate sat next to a man, who had a habit of pinching. She was on the verge of telling him off when she calmed herself with this reasoning:

"Why should I get angry? It's his problem, not mine."

Well, Anyway, It's a Cure

"Why do I drink so much? I'll tell you why I drink so much! I've got a bad case of amnesia and I drink to forget it!"

Ticklish Situation

Personnel Manager: "Are you ticklish on points of honor?"

Applicant: "Yes, and under the arms, too."

Line of Duty

It was during World War II when women officers were considered first as officers, then as women, that a young female lieutenant on board ship and bound for Europe, received her copy of instructions, which read:

"Notice to all officers:

"If at all possible, plan to spend your first night on shipboard, below with your men.

"They'll never forget it, and you'll never regret it."

Not So Particular

The third time she paraded across the hotel lobby, an observant young man came forward and asked:

"Are you looking for someone in particular?"

"Oh no," she replied, "I'm satisfied if you are."

The Jet Age

"I know we're traveling faster than sound," the passenger said, "because the stewardess slapped me before I got a word out of my mouth."

Death on Insurance

Young wife to insurance salesman: "If I take out an insurance policy on my husband and he dies tomorrow, what will I get?"

"The electric chair," said the departing salesman.

An Honorable Gent

In explanation of his bruised and scratched face, the man said, "I was fighting for a woman's honor."

"Must have been a tough fight," a friend answered.

"It was," the victim admitted, "and she kept it."

Love and Marriage

Millie: "I understand Grace had two proposals last night."

Tillie: "Was either one for marriage?"

Knowledge from Reading

Upon noticing a highway sign in behalf of Smith Brothers cough drops with the wording:

"Take one to bed with you," the woman driver remarked to her companion:

"He'd have to shave first."

Mr. Know-It-All

Lecturer (in village hall): "Now you all know what a molecule is."

Chairman (interrupting): "Most of us do, but perhaps you'd better explain for the benefit of those who have never been up in one."

1960 OIL DIRECTORIES

19 pocket-size, plastic-bound personnel directories covering the entire oil industry of the world, from top executives to foremen. Over 135,000 key men are listed. First seven books cover Producing and Drilling Contracting.

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12. Oil Directory of Companies Outside the U. S. A. and Canada
13. Oil Directory of Canada
14. Directory of Geophysical and Oil Companies Who Use Geophysical Service
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ACOUSTIC WELL SOUNDER

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For determination of liquid level in producing oil wells, static or pumping bottom-hole pressure, productivity index, pump performance, adjustments for gas lifts, etc.

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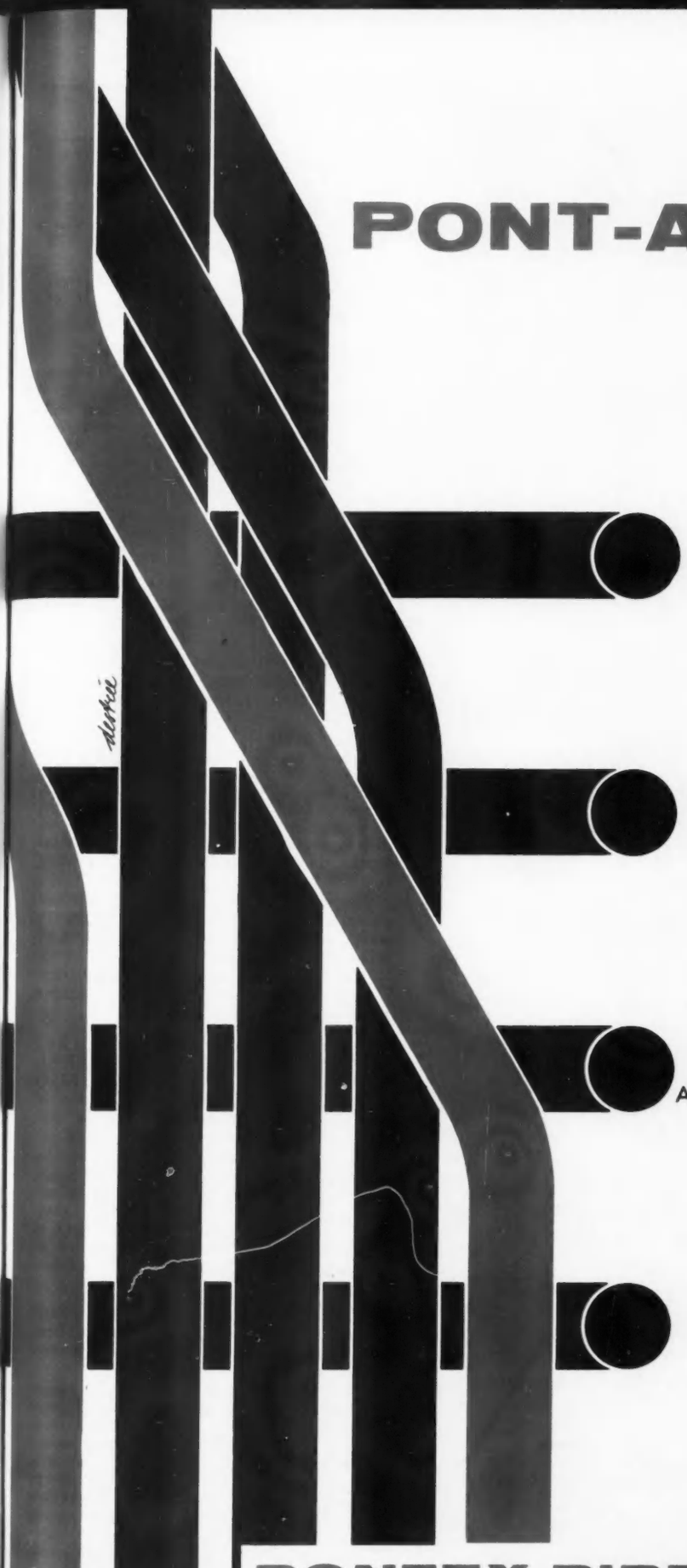

PONT-A-MOUSSON

FRANCE

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WELDED PIPE
DUCTILE IRON PIPE
CENTRIFUGALLY CAST — SOCIÉTÉ DES FONDERIES DE PONT-A-MOUSSON

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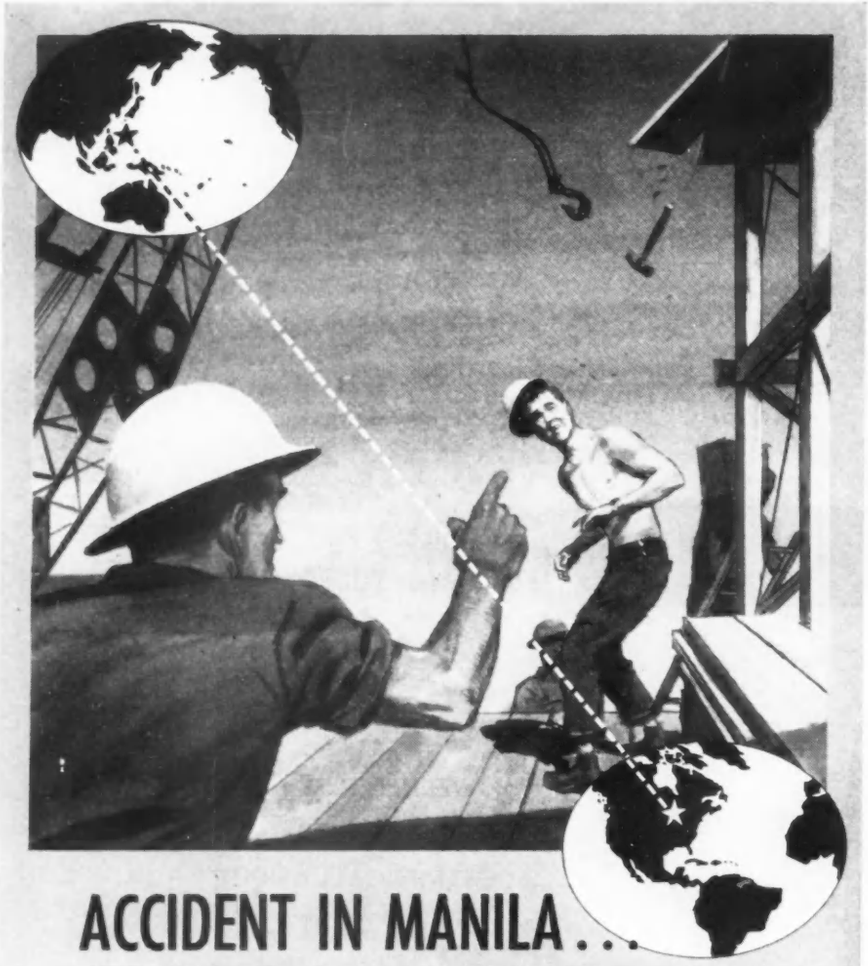

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BOOKS

GEOLOGY OF THE PINTO CANYON AREA, PRESIDIO COUNTY, TEXAS, Bureau of Economic Geology, The University of Texas, David L. Amsbury, 75 cents.

Latest in its series, this publication consists of a map in color on a scale of 1:62,500 and accompanying text.

BALL BEARING MAINTENANCE, University of Oklahoma Press, Norman, Okla., Johnny Riddle, $6.

Ball Bearing Maintenance is devoted entirely to the principles of maintenance which are known to contribute to good bearing performance and a balanced service life. In simple terms, it tells how the consumer can begin at once to enjoy better ball bearing performance. Illustrated with approximately 300 photographs and diagrammatic sketches.

EXECUTIVE'S MAP OF PERMIAN BASIN PRODUCING FORMATIONS (1959 Edition), Southwest Mapping Company, 1105 Continental Life Building, Fort Worth 2, Texas, $10 to $32.50.

This is a complete oil reference map covering all or parts of 43 counties in West Texas and Southeast New Mexico. It is beautifully lithographed in seven colors, each producing horizon in each field designated by a color legend. The base map, available also without color, shows sections, surveys, towns, railroads, oil field names, producing wells, dry holes with operator and farm names and total depths, drilling wells up to date February 1, 1959.

The map was compiled from Southwest ownership maps, numerous reference books, oil report services, and 30 years of personal mapping experience in the area.

Prices vary, depending on whether color is used and whether the map is on paper or cloth.

GEOLOGY AND MINERAL RESOURCES OF SANTA YSABEL QUADRANGLE, SAN DIEGO COUNTY, CALIFORNIA, Division of Mines, Department of Natural Resources, San Francisco, Calif. $1.50.

The descriptive text is accompanied by a colored geologic map and an economic map, both on a topographic base, a structure map and sections, numerous photographs. The report represents the work of Richard Merriam of the Department of Geology, University of Southern California, Los Angeles.

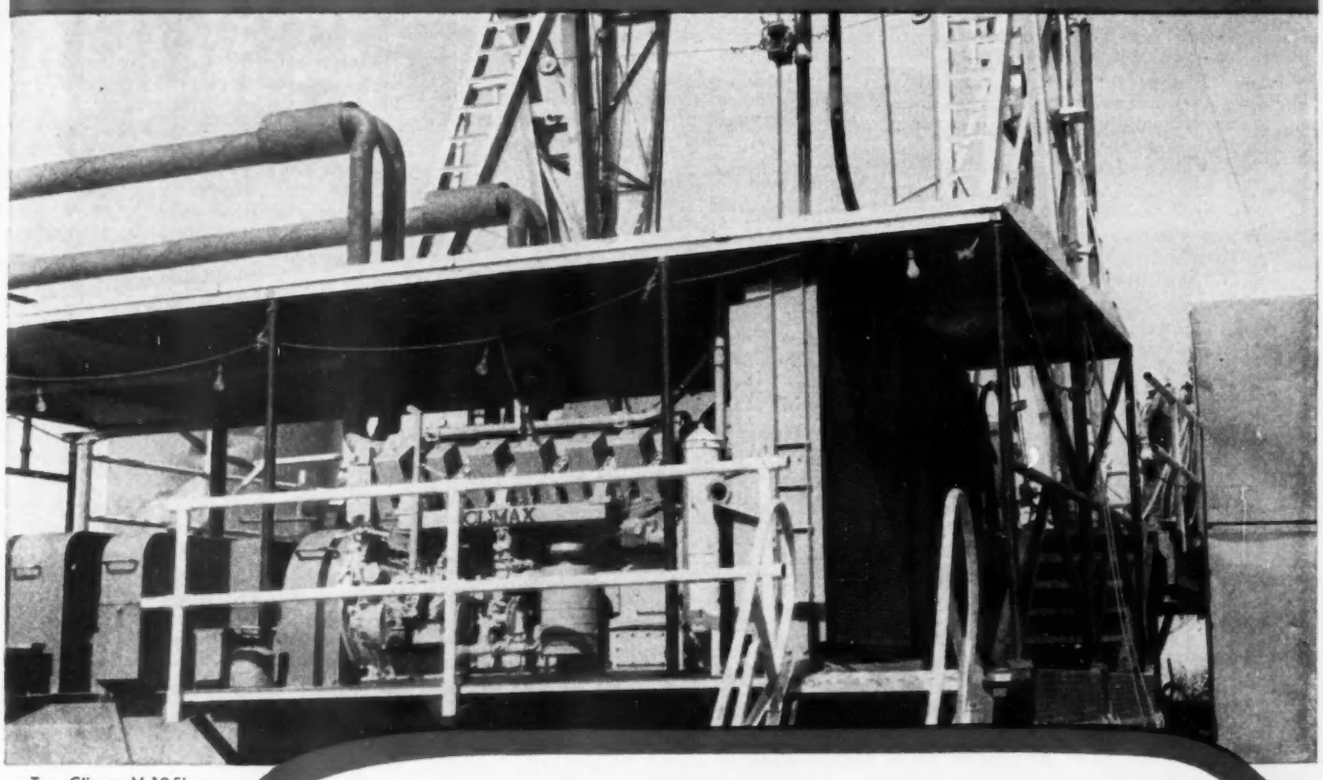
ADVENTURE IN OIL, Sidgwick and Jackson, London, Henry Longhurst, Foreword by the Rt. Hon. Sir Winston Churchill.

The story of the British Petroleum Company is the story of an enterprise which began at the turn of the century with a few pioneers in the barren wastes of southwest Persia, and today produces, sells, or searches for oil in almost every country of the Free World. The author presents it as a story not of a company but of people.

The foreword is composed by Winston Churchill.

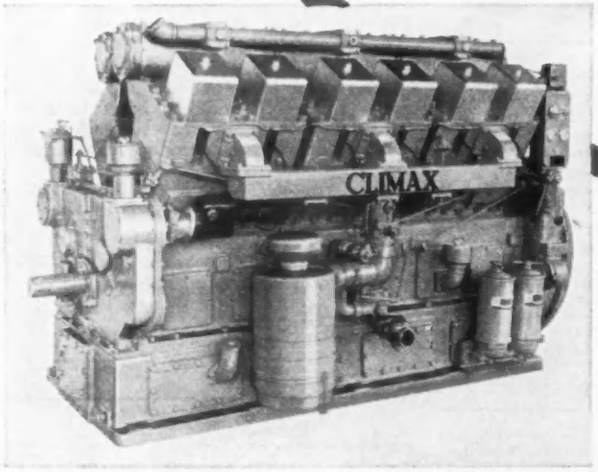
Besides just being a story of the people and of the British Petroleum Company, many interesting illustrations run throughout the book that are valuable in helping to tell the story.

where the PAY-OFF is on RELIABILITY!



Two Climax V-125's on a Cleveland County, Oklahoma rig.

CLIMAX OIL FIELD POWER



Climax Engines have proven their reliability in hundreds of oil field installations. Single, well balanced design, rugged construction, and quality materials make them smooth running . . . for years!

Model V-125
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POWER UNIT PUMPING and DRILLING HP—CONTINUOUS DUTY

MODEL	Bore and Stroke	Displacement	Torque @ RPM	BRAKE HORSEPOWER AT SPEEDS INDICATED					
				600	700	800	900	1000	1100
R-110	6⅛ x 7	824	468 @ 800	52	62	71	79	86	91
R-165	6⅛ x 7	1238	684 @ 750	81	93	105	117	127	135
K-67	7 x 7	1616	955 @ 805	110	129	145	161	176	188
K-75	7½ x 7	1855	1090 @ 800	126	146	166	185	204	218
V-80	7 x 7	2155	1240 @ 850	140	165	188	210	230	246
V-85	7½ x 7	2474	1440 @ 900	164	194	223	246	266	284
V-122	7 x 7	3232	1915 @ 900	217	258	293	328	353	378
V-125	7½ x 7	3711	2220 @ 850	242	292	340	384	417	442

Write for descriptive literature

CLIMAX ENGINE MANUFACTURING CO. • DIVISION OF WAUKESHA MOTOR COMPANY
FACTORY—CLINTON, IOWA

OIL AND GAS MAP OF LARUE COUNTY, Kentucky Geological Survey, University of Kentucky, Thomas J. Crawford, $2.20.

An oil and gas map of Larue County, Ky., the first since 1931 to be compiled for this county, has been published.

Larue County is located immediately north of Green County which has been the center of extensive shallow oil exploration and development.

Thomas J. Crawford, survey geologist, gathered the information for the map. One hundred and seventy wells in the county are pin-pointed and identified.

The map is on a sheet 35 inches by 32 inches and is in two colors.

GUIDE TO THE LITERATURE OF PETROLEUM, Science Information Associates, P. O. Box 2284, Houston 1, Texas, $1.75.

Science Information Associates has published the first portion of Guide to The Literature Of Petroleum. It consists of 43 multilithed sheets, divided into the following parts: Introduction; Reference Problems and Procedures; General Reference Works; Serials; Government Publications; Patents; Trade and Technical Associations; and Dissertations, documents and miscellaneous sources.

For convenient handling, it is stapled so that it can be put in whatever type of folder or binder you desire. Emphasis has been placed on methods of finding the information you need rather than merely listing the many names of books, serials and organizations. A supplement or appendix will be issued at a later date which will enumerate specific books and reference works for the many special fields relating to petroleum.

PETROLEUM PROCESSING, PRINCIPLES AND APPLICATIONS, McGraw-Hill Book Company, New York, R. J. Hengstebeck, Standard Oil Company (Indiana), $10.

Petroleum Processing includes a sufficient amount of information covering such topics as products and raw materials, general operations, separation processes, moving beds and fluidized beds and solids, pyrolysis, catalytic cracking, catalytic reforming, alkylation and polymerization, isomerization, lube oil, wax, and asphalt processes, hydrogenation, acid clay, and hydrogen treating, sweetening mercaptan extraction.

Major refining operation is described with important factors discussed in detail. The author emphasizes practical applications, although he includes theoretical information where it contributes to understanding the applications. Recent advances are covered in the treatment; obsolete processes are discussed only as they bear on modern technology, or as they provide useful background information.

SCHEDULE OF WELLS, Saskatchewan Department of Resources, Government Administration Building, Regina, Saskatchewan, Canada, $7.

The Saskatchewan Department of Mineral Resources has announced the publication of a Schedule of Wells for the period from January 1957, to December 1958.

The 394-page book is volume seven in this series and contains pertinent data on all wells drilled during the past 2 years.

The wells are listed in order of land location. The 1957 field wells which were reported in a previous schedule are identified by name and location only in this issue. In addition, non-confidential details of wildcat drilling during 1958 are included. For easier reference, three indexes, namely, location, official name and common name, are also included.

PETROLEUM REVIEW, KENT COUNTY, TEXAS, Phifer Petroleum Publications, Houston, Robert L. Phifer, $10.

Compiled from the record and hearing files of the Railroad Commission of Texas, this oil reference book is the latest in its series on West Texas counties. It outlines the discovery, development and production of 27 fields that have been discovered in the county since 1946. The individual field record lists location, discovery well, surveys (block and section numbers), known subsurface structural data, rules and regulations among other valuable, quick-reference facts and figures.

Development progress of each field can be determined as the number of wells at the end of each year is opposite production. The book contains 27 illustrations which include structure maps, log of discovery wells and a map of the county with the fields in color. Information in the book is current through June 1959.

WORLD OIL'S Trading Post CLASSIFIED ADVERTISING

RATES: Regular Classified (undisplayed) **set in this size type: 20 cents per word. Minimum charge $4. Blind box address in our care counts six words. Replies forwarded without charge. Display Classified ads,** set in suitably larger type with ruled border, **$13.50 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. All classified ads payable in advance.** Send copy and checks to: **Trading Post Classified Section, World Oil. P. O. Box 2608, Houston, Texas.**

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■ **100 Miles 10¾". 307 Wall Pipe. Used, in excellent condition. Immediate delivery. Plain end Machine cleaned, coated. Central Ohio Pipe Co., P. O. Box 5412, Shepherd sta. Columbus, Ohio 3. Phone C.L.36527.**

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■ 3 Cable Tool Rigs for sale or lease. Drilling capacities 3500, 4000 and 4500 feet. Fully equipped, first-class shape. Call Mr. Burris, MU 2-2240, Midland.

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Former drilling contractor and oil producer that has recently sold out is interested in making contact with an individual, group or company to manage and supervise their oil and gas operations, domestic or foreign. Location immaterial. R. Makin, Box 1628, Petroleum Building, Hobbs, New Mexico.

■ Exploration Geologist—7 years South Louisiana experience, planning to go Independent after the 1st of the year. Desires to make contact with people willing to spend tax money, or small aggressive independent. Box 204-W, WORLD OIL, Houston, Texas.

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■ Mechanical Engineer with 5 to 10 years experience in designing high pressure and low pressure well head equipment must be capable of supervising engineering department. Position now available. Salary open. Box 205-W, WORLD OIL, Houston, Texas.

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Well-established successful firm has opening in an expanding sales department for young man looking for an opportunity in sales work. Must be college graduate, not over 33, in good health, ambitious and not afraid of work. Oil industry experience desirable. The man we are looking for will be trained at home office before moving into sales work on basis of salary plus commission incentive and traveling expenses. Our own personnel know of this advertisement. Your reply will be confidential and should be sufficiently complete to merit contacting you for an interview. Address Box 200-W, WORLD OIL, Houston, Texas.

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CARDWELL PLUNGER PUMPS WEIGH LESS DEVELOP MORE HYDRAULIC HORSEPOWER

Cardwell's new V-Series Mud Pumps weigh as much as TWO-THIRDS LESS and occupy as much as THREE-FOURTHS LESS space than competitive pumps with comparable horsepower. Yet — performancewise — they answer every demand for more hydraulic horsepower at the drill bit. They are the only pumps on the market today capable of developing high pressures over sustained periods of time — economically!

If you're looking for a high-pressure mud pump that weighs less and is capable of developing more bit horsepower which requires a minimum of normal expendables — investigate the Cardwell V-Series: Today's lightest-per-horsepower, more compact, completely balanced and economical drilling pumps.

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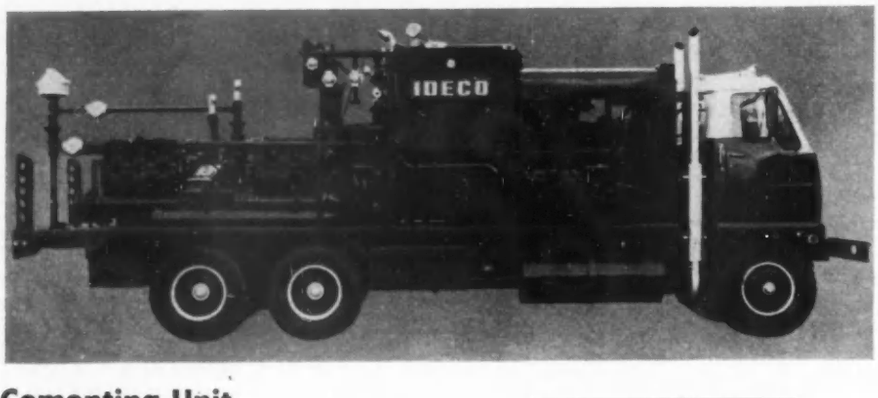
Request Mud Pump Bulletin No. 2-5-59
Cardwell Manufacturing Co., Box 2001, Wichita, Kans.
Cable: ALLSTEEL • Phone: AMherst 7-3311

CARDWELL V700 — 700 input horsepower mud pump on location in New Mexico.

What's New in EQUIPMENT and SERVICES

Drilling - Production - Exploration



Cementing Unit

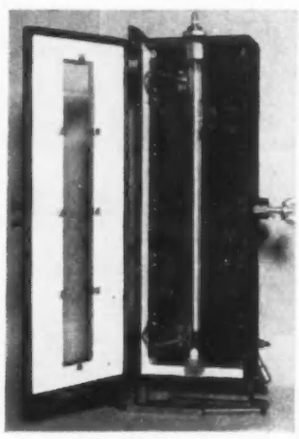
This compact cementing unit is skid-mounted on the truck chassis for easy removal and transfer to a different truck without necessity of reinforcing the frame. Air controls for both engines and pumps are located in a panel on the operators platform in the center of the truck float. (IDECO, Inc., One of the Dresser Industries, Inc. Supplements data on Pages 2649-2716-H, 1958-1959 Composite Catalog.)

For more data, circle E1 on postcard

New Casing Protector

Grip-Lok, economy model latch-on protector with locking pin is available. Protector is of all-purpose synthetic rubber, bonded to a hinged steel inner cage to form a series of interlocking faces at latching ends. Locking pin drops through compound hinge element to hold protector to drill pipe. Can be installed or removed by one man in less than 10 seconds. (Byron-Jackson Tools, Inc., a Subsidiary of Borg-Warner Corp. Supplements data on Pages 945-1060, 1958-1959 Composite Catalog.)

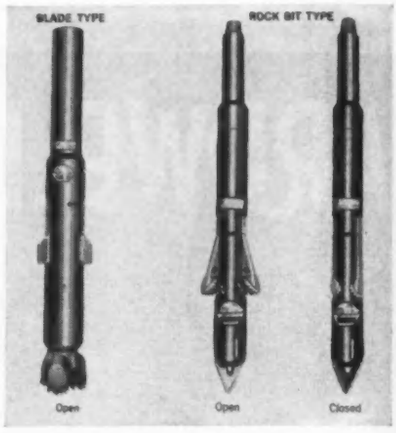
For more data, circle E2 on postcard



Liquid Level Controller

A new automatic liquid level controller has been developed for controlling both high and low levels on a given tank. It is well-suited for use on lease automatic custody transfer units. The "Phil-Mag" consists of a free-floating mercury column with a magnet, which transfers static tank pressure to an electrically controlled instrument outside the tank. (Enardo Manufacturing Co. Supplements data on Page 1641, 1958-1959 Composite Catalog).

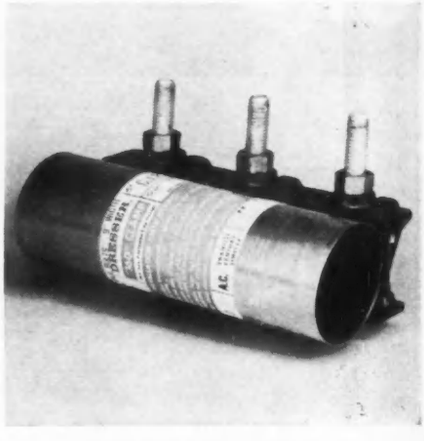
For more data, circle E3 on postcard



Expanding Hole Opener

Available in rock bit type and blade type, this new tool is run through casing to enlarge the hole for such operations as gravel packing, cementing, landing casing or liners, wall scraping or for any purpose where a larger hole diameter is desired. Blade type tool available with a 10-inch diameter body and 15-inch reaming diameter for use in 12-inch diameter hole. Rock bit types available in various diameters. (The Servco Co. Supplements data on Pages 4485-4504, 1958-1959 Composite Catalog.)

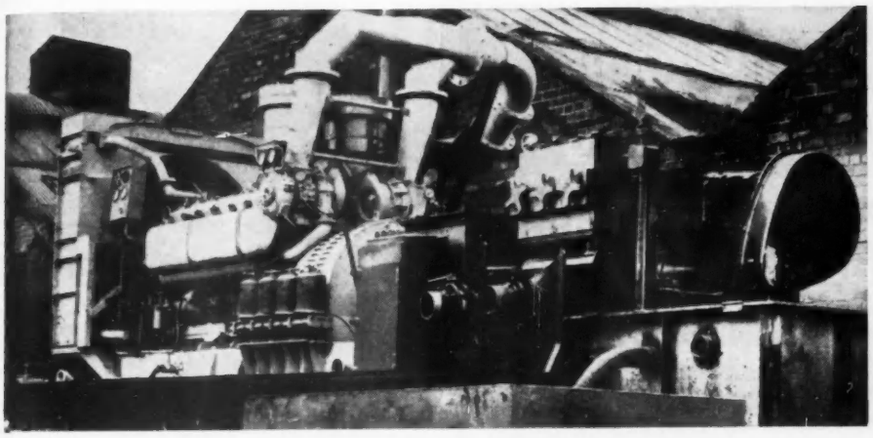
For more data, circle E4 on postcard



Small-Diameter Pipe Clamp

Here is a new small-diameter pipe repair clamp, the Dresser 2-inch and 3-inch '360' all-around repair clamp. Made of stainless steel and Grade A malleable iron lugs, these clamps provide an easier-to-install, more efficient method of repairing full breaks or holes in asbestos-cement and cast iron water lines in oil fields, water and sewerage systems, plants and factories. (Dresser Mfg. Div., One of the Dresser Industries, Inc.)

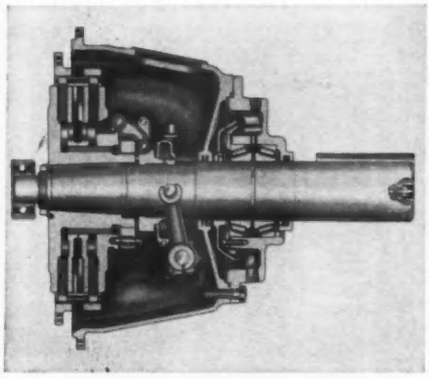
For more data, circle E5 on postcard



Diesel Driven Pump Set

This trailer-mounted, diesel driven pump set for duties in the oil fields has been introduced. It is designed primarily for treating oil wells by the formation fracturing metod. The set consists primarily of a Paxman diesel engine driving an 'OILWELL' Super 48 Triplex Plunger Pump through a 2-speed chain and sprocket type transmission box is mounted on a semi-trailer. [Armstrong Whitworth (Metal Industries) Ltd.]

For more data, circle E6 on postcard



New Power Take-Off

A new power take-off for high-energy, high-speed applications has been introduced. Designated Model IBF-214P, this unit offers three distinct advantages over standard PTOs: It withstands high-energy heat loads; it can be applied to high-speed engines up to 3,380 input rpm; it operates up to 6 months between lubrication periods. Features large tapered roller bearing to withstand heavy side loads. (Twin Disc Clutch Co. Supplements data on Pages 49-54-4955, 1958-1959 Composite Catalog.)

For more data, circle E7 on postcard

New Blade String Tool

A new replaceable blade string tool can be converted by simply changing the blades for use as uphold guide, casing mill or reamer, or as bit stabilizer. No welding, locking nuts or plates are used to hold the blades. Instead, elastic steel pins are inserted into contoured longitudinal grooves on each side of the blades and in the body. (Kinzbach Tool Co., Inc. Supplements data on Pages 2857-2876, 1958-1959 Composite Catalog.)

For more data, circle E8 on postcard

Oil Well Pumping Controller

A newly designed oil well pumping controller with wide enclosure, separate operator's access door and a fully gasketed upper compartment has been announced. It is available in NEMA Sizes 0-4 for control of oil field motors up to 100 horsepower. Wide enclosure is designed to permit plenty of room for wiring and maintenance on the part of the operator. (General Electric's General Purpose Control Department.)

For more data, circle E9 on postcard

SLICKEST WAY TO TD

USED AND RECOMMENDED

. . . *especially* under conditions where DRAG, TORQUE, OR THE HAZARD OF STICKING DRILL-PIPE, LINER AND CASING are encountered.

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have proved the effectiveness, versatility and trouble-free application of

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The cooling of liquids and gases or condensing vapors by air is the economical answer to many heat transfer problems!

HC® HORIZONTAL CORE UNITS by Young are specifically designed to handle a wide range of processing applications normally cooled by water!

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They are ideal for cooling acids, light or heavy end liquids, caustics, oils, or for condensing vapors or steam, or for maintaining temperature control of various types of solutions.

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Young RADIATOR COMPANY
RACINE, WISCONSIN
Creative HEAT TRANSFER ENGINEERS
Executive Office: Racine, Wisconsin, Plants at Racine, Wisconsin, Mattoon, Illinois

Lined Pipe Fittings

A complete line of Plastisol (PVC) lined pipe fittings in malleable iron or aluminum has been announced. New Plastisol lined fittings are supplied with grooved ends for quick-jointing pipe with mechanical couplings. New fittings are available in elbows, tees, reducing tees, reducers, caps and adapter nipples in sizes from 1¼-inch through 12-inch diameters. (Victaulic Company of America. Supplements data on Page 4988, 1958-1959 Composite Catalog.)

For more data, circle E10 on postcard

Oil Well Pumping Control

A new oil well pumping control for 762 or 880 volt applications has been introduced and is available in two sizes up to 75 hp applications. The special weatherproof enclosure has a sealed compartment housing all elements except the overload relays. The overloads are in a ventilated portion of the enclosure insuring maximum motor protection at any ambient temperature. (Reincke, Meyer & Finn, Inc.)

For more data, circle E11 on postcard

ON TEST LINES –

Chiksan Swivel Joints combine flexibility and safety

When temporary lines carry high pressures, operators naturally turn to flexible all steel *hose loops* made up with Chiksan Joints and Weco Unions. Their freedom from the possibility of line rupture, their portability and their little need for attention have made them the standard of drilling, producing and service men everywhere. Chiksan Joints and their partner Weco Unions are sold by leading supply stores everywhere.

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-BORN IN FREEDOM
WORKING FOR PROGRESS

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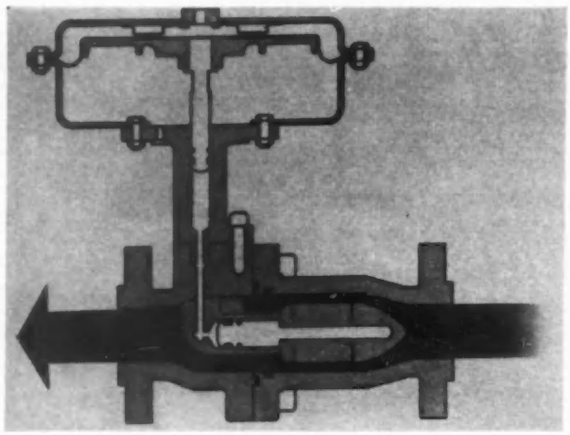
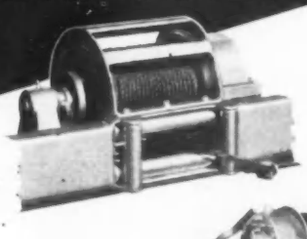


Jet Stream Regulator

A new pressure reducing gas regulator with straight-through flow and positive shutoff is now being manufactured for gas and liquid pipe lines and process service. Eliminates jetting of high speed gas and transient particles into the side of the regulator. Also reduces sound vibration. Can be regulated from full flow to bubble-tight shutoff in three seconds. (APCO, Division of Textron, Inc.)

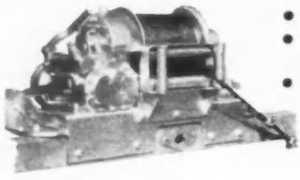
For more data, circle E12 on postcard

KING WINCHES . . . for 'Jeep' vehicles, International*, Chevrolet, GMC, Ford, Land Rover and others.



COMPLETE, READY-TO-INSTALL KING FRONT-MOUNT WINCH ASSEMBLIES FEATURE:

- winch side arms to reinforce truck frame
- bronze-bushed, 4-way cable guide rollers
- cable drum guard
- heavy-duty pipe bumper
- needle-bearing, universal-joint spline-shaft drive assembly
- Timken bearings on worm



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King Winches keep you moving through the most difficult terrain . . . you get action where there's no traction with dependable pulling power. King power winches have pulling capacities of 8,000 to 19,000 lbs.

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FULL AND HALF CABS

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KOENIG ALL-STEEL CABS HAVE THESE SUPERIOR FEATURES:

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- SAFETY
- COMFORT
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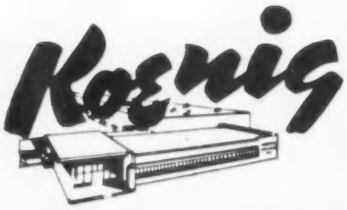
Roll-down windows, full opening . . . full panelboard head lining and masonite door lining . . . safety glass throughout . . . all-steel welded construction . . . door locks.



IRON WORKS, Inc.

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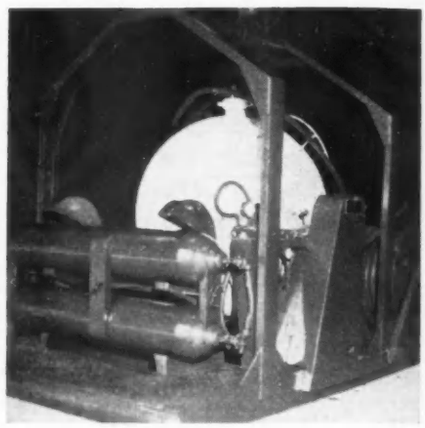


New Fire-Fighting Unit

A new type fire-fighting unit, called Fire Boss, is a radically simple apparatus which according to the manufacturer, can cope with the largest rig fire. An invertible sphere stores 1,500 pounds of nitrogen-propelled dry chemicals. Spherical design provides a stronger, steadier flow by eliminating dead spots for better circulation of the powder and nitrogen. Though two operators are recommended for the unit, one untrained man can use it effectively. (Fire Boss, Inc.)

For more data, circle E13 on postcard

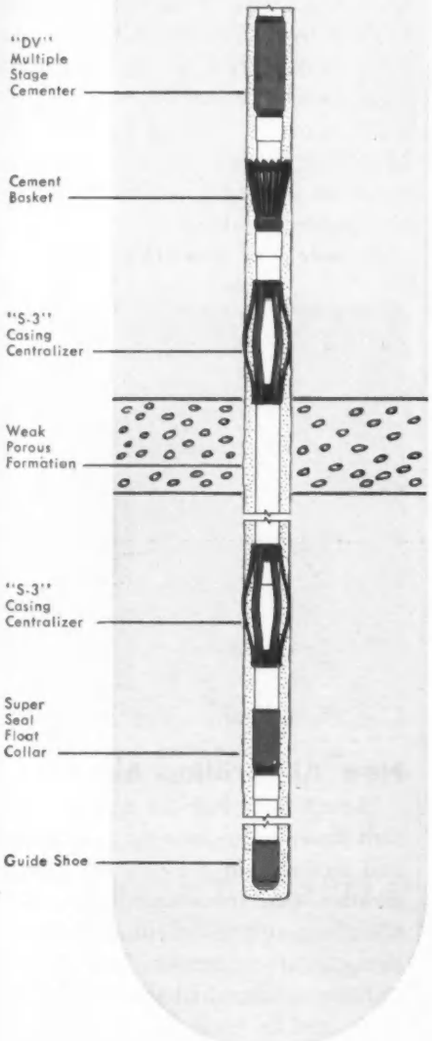
Buttress-Thread Casing

A new line of buttress-thread casing which makes joints strong as the pipe itself has been made available. High tensile strength coupled with the 3-degree flank angle of the thread make the joint almost equal in strength to that of the body pipe itself. Available in 5½-inch O.D., 7-inch O.D. and 9⅝-inch O.D. Buttress-Threads are principally applied to API N-80 grades. (Republic Steel Corporation.)

For more data, circle E14 on postcard

FOR THOSE WEAK, POROUS FORMATIONS...

HALLIBURTON CEMENT BASKETS



OPERATIONAL DIAGRAM
FOR CEMENT BASKET
AND OTHER HALLIBURTON CASING PRODUCTS

Rugged, easy to use and economical... that makes this cementing tool important for porous or weak formations.

The Halliburton Cement Basket is especially designed to provide a dependable annular bridge that will reduce fluid loss or break down of weak formations, and help support the cement slurry column until its initial set.

The Halliburton Cement Basket is expertly constructed of high strength flexible steel staves, mounted on a steel ring that slips over casing and an insert liner of heavy duty water-proof canvas that is riveted to the staves and ring. The insert liner is resistant to oil, weak acids and mud chemicals.

The steel staves permit fluids to by-pass upward while running casing, circulating or cementing. After the casing becomes stationary, or circulation is stopped, the basket expands to the bore wall like an inverted umbrella. Any downward movment of fluids or solids against the basket firmly presses the staves and insert liner close to the wall to form an effective annular bridge.

Halliburton Basket Casing sizes are available from 4½" to 10¾", covering minimum through maximum hole sizes from 6¾" through 16¼" inclusively.

FOR IMPROVED CEMENTING RESULTS USE HALLIBURTON CEMENT BASKETS...

★ on casing below a Halliburton "DV" Multiple Stage Cementer to retain cement and aid in protecting weak formations by reducing the hazard of slurry loss or formation breakdown.

★ on a liner string below a Halliburton Type "H" Solid Baffle Collar to hold cement pumped through the ports in the collar into basket to partially protect the producing zone or any lower formation from contamination.

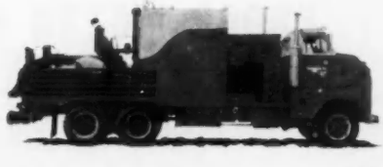
★ on casing for a straight casing cementing job to help support the column of cement and give extra protection to any weak or porous area.

★ with EZ Lok Limit Clamps or Solid Set Screw Limit Rings for selective spacing of Baskets between casing collars *without welding*. Split Dent Limit Rings furnished with each Basket may be spot welded, if desired, on pipe above and below each Basket to permit movement of casing with Basket open.

For stronger, safer cementing, specify Halliburton Cement Baskets... and other Halliburton Cementing Tools and Equipment—"job-proven" on more than two million cementing operations. Contact your nearest Halliburton Representative for complete information.

HALLIBURTON
CEMENTING SERVICES

HALLIBURTON OIL WELL CEMENTING COMPANY • DUNCAN, OKLAHOMA



"284 SERVICE CENTERS — JUST MINUTES AWAY FROM YOUR WELL"

For more data on advertised products, use Readers' Service Cards, last page.

JET-LUBE Extreme Service

LUBRICANTS & SEALS

Consistent under all extremes of temperature

Prevent galling and metal pick-up. Create a perfect seal.

MADE IN ENGLAND and immediately available to oilfields throughout Europe, the Middle and Far East

JET-LUBE LTD.

PAGET WORKS, PARK LANE, WOLVERHAMPTON, ENGLAND
ALSO 26/32 CAXTON STREET, LONDON ENGLAND. CABLES *JETLUBE LONDON.*

Take Your Pick
OF THESE BROOK A.C. MOTORS

THE Open Drip Proof NEMA Rerate Motor occupies less space—weighs 12 to 15% less than the Open Drip Proof Motor in the old frame. This is no case of "Riding horse versus draft horse"—both motors have equal stamina. Some prefer the old frames, especially where space is no factor. Brook warehouses coast-to-coast carry both types in stock. You can't find a better motor at any price, yet Brook Motors cost substantially less, because of volume production, modern techniques, world-wide distribution and a realistic pricing policy. Brook Motors available from 1 to 600 H.P. All standard enclosures. Write for literature and name of your Brook Dealer.

world's most respected motor

BROOK MOTOR CORPORATION

3302-04 W. PETERSON AVE., CHICAGO 45, ILL.

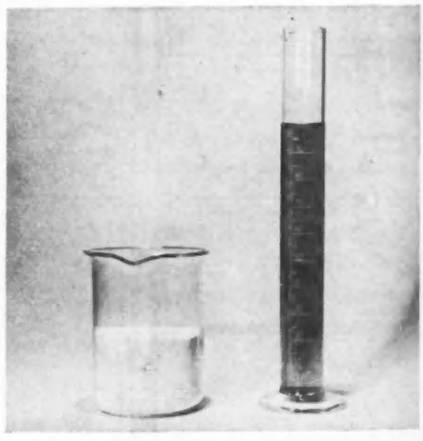
In Canada: Brook Electric Motors of Canada Ltd., 250 University Ave., Toronto, Ont.

SINCE 1904
BROOK MOTOR CORPORATION

Pee Wee Pumping Unit

A new model pumping unit for extremely shallow, stripper wells has been announced. Structural bearings are made of non-metallic material to help absorb shock loads and to run longer between lubrications than other types. Gear reducer has been designed to both API and AGMA specifications. Simplicity in design permits highest quality construction with maximum economy. (Alten Foundry and Machine Works, Inc. Supplement data on Pages 173-176, 1958-1959 Composite Catalog.)

For more data, circle E15 on postcard



New Air Drilling Aid

Howco-Sorb has the ability to absorb water up to four times its weight and still remain a loose, free flowing powder. Has from six to eight times absorbing abilities of similar materials and uses are numerous. After slugging to remove accumulated water, Howco-Sorb can be used as drilling dust when water production isn't excessive. (Halliburton Oil Well Cementing Co. Supplements data on Pages 2177-2284, 1958-1959 Composite Catalog.)

For more data, circle E16 on postcard

Skid-Mounted Tank

Supplies

Each Bethlehem oil-country store carries the finest in production equipment and drilling supplies—and stands ready to meet your time schedule on delivery.

Smiles

Our stores—all friendly places—offer 'round-the-clock service, custom-tailored to your individual needs.

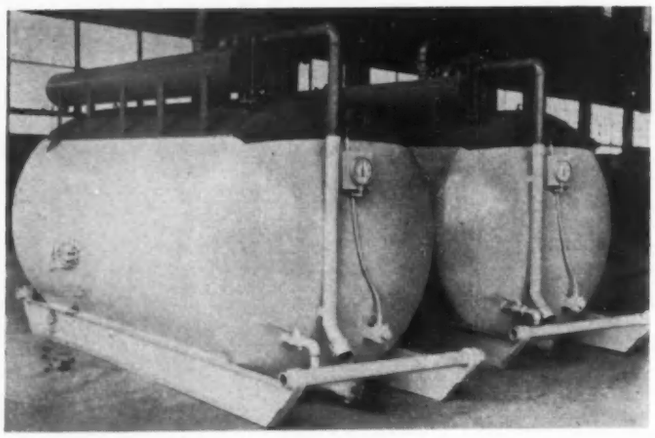
Services

Bethlehem engineers are qualified to advise you on the selection of production equipment such as pumping units, rods, bottomhole pumps. And we'll work with you on your secondary recovery programs—our experience includes both package and turnkey services.

Next time, call on Bethlehem

BETHLEHEM STEEL COMPANY, SUPPLY DIVISION
General Offices: 21 East Second St., Tulsa, Okla.

BETHLEHEM STEEL
SUPPLY DIVISION

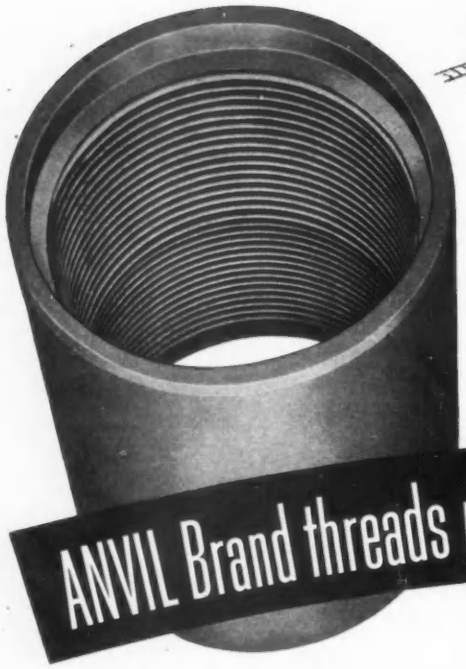


Skid-Mounted Tank

Development of a skid-mounted vacuum-type tank, designed to recover liquid drilling mud from open storage pits at oil well drilling sites, has been reported. Unit recovers and discharges mud under pressure through valve mounted at front bottom of tank. Power is supplied by separate gasoline-driven vacuum pump. Can recover full load of 17-pound mud (35,700 pounds) in 10 minutes. (Delta Tank Mfg., Inc. Supplements data on Pages 1526 and 2456-2460, 1958-1959 Composite Catalog.)

For more data, circle E17 on postcard

When you're making string



ANVIL Brand threads make it faster!

ANVIL Brand threads are clean, accurately tapered, and electro-galvanized; chamfers and recesses are precision machined. The result is a coupling that makes up fast and firm, without galling.

When you're making string—or pulling it—Anvil Brand Couplings give you the trouble-free service that helps you get lower costs on drilling and production.

Anvil Brand Fittings—A.P.I. Couplings for all oil field uses, as well as bushings, plugs, and nipples, are sold through your nearest supply store. Engineering service is always available from Anvil Brand Representatives in key oil country locations. Write today for information.

PITTSBURGH PIPE AND COUPLING COMPANY
ALLISON PARK, PA., U.S.A.
In the Greater Pittsburgh Industrial District
Subsidiary: Anvil Products, Inc., Longview, Tex.
Affiliate: Canadian Coupling and Fittings, Ltd., Simcoe, Ont.

ANVIL BRAND
forged seamless and wrought steel pipe fittings

Slim Hole Drill Tool

A line of slim hole drilling production equipment for the increasing use of 2½-inch tubing for casing and 1¼-inch or 1½-inch tubing as the oil string has been developed. The combination tee and stuffing box has a female thread and screws directly onto the tubing, eliminating one threaded connection and resulting in a considerably shorter hook-up. (Hercules Tool Co. Supplements data on Pages 2317-2336, 1958-1959 Composite Catalog.)

For more data, circle E18 on postcard

New Quadruple Valve

A quadruple valve with four 2-inch through conduit gate valves in a single body for use on quadruple completion christmas trees is now available. The new valve is available in the 2-inch size up to 5,000 pound API maximum working pressure. Features include seal bonnets, parallel expanding gates, closed packing boxes and super finished stems. (W-K-M Division of ACF Industries, Inc. Supplements data on Pages 4993-5060, 1958-1959 Composite Catalog).

For more data, circle E19 on postcard

Announcing the NEW

BJ Centrilift

Submersible Motor Centrifugal Pump

Pumps very large volumes of fluid at lowest cost per barrel!

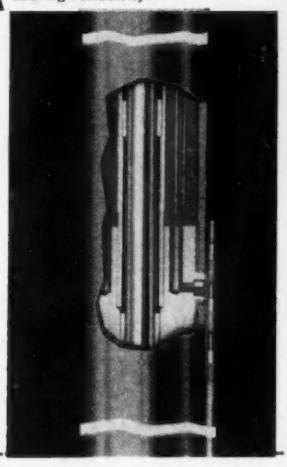
Byron Jackson announces the BJ Centrilift—a new sub-surface oil well pump designed for economy and dependability over a wide range of industry needs. These include water supply wells in flood projects... production wells in natural water drive or in artificial floods with low oil/water ratio... deep wells... fresh water or chemical brine wells... crooked or whip-stocked wells... and special applications for severe corrosive or abrasive conditions.

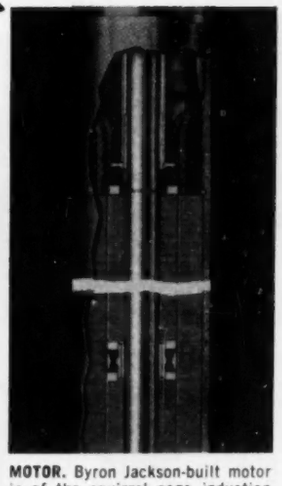
The BJ Centrilift combines the extra capacity of centrifugal pump design with the rugged economy of a close-coupled BJ Submersible motor drive. Submerged in well fluid and suspended on standard tubing, the BJ Centrilift offers the highest operating efficiencies with the lowest horsepower requirements... the lowest lifting cost per barrel of fluid. Fast, dependable field service is available through BJ Tools' network of plants, warehouses and field service centers.

A product of more than 87 years of centrifugal pump leadership

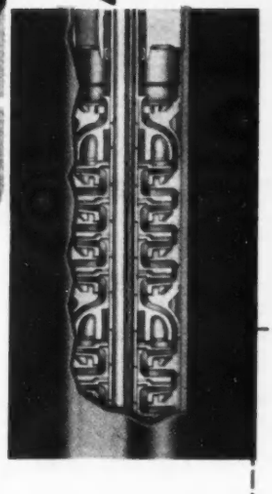
Byron Jackson has been a leading pump manufacturer since 1872... pioneering in centrifugal pumps, including both deepwell turbine and submersible motor types. From this 87-year background of experience and leadership comes the great new BJ Centrilift—designed to serve a growing need for superior sub-surface pumps for the oil industry.

SEAL SECTION. BJ Centrilift utilizes multiple mechanical seals, combined with simple pressure equalizing system for positive sealing reliability.





MOTOR. Byron Jackson-built motor is of the squirrel cage induction type... oil-filled to prevent internal corrosion and provide long, maintenance-free operation.



PUMP. Capacities of 500 to 17,000 BPD, in as many stages as required for operating head. Diameters to fit well casing sizes of 5½", 7", 8⅝". Bowls, impellers and shafting of corrosion-resistant materials for long life, low maintenance.

MAIL THIS COUPON FOR ADDITIONAL INFORMATION

Please send price and performance data on BJ CENTRILIFT equipment for the following application:

WELL NAME _____ WELL NUMBER _____

WELL LOCATION: FIELD _____ COUNTY _____ STATE _____

DEPTH _____ CASING SIZE _____

PRESENT PRODUCTION, BPD _____

DESIRED PRODUCTION _____ ESTIMATED LIFT _____

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

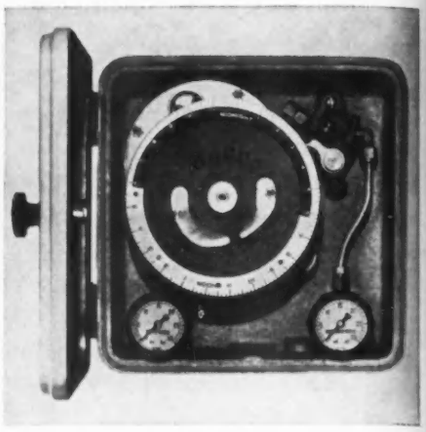
Byron Jackson Tools, Inc.

Oil Well Pump Section

A Subsidiary of Borg-Warner Corporation

P.O. Box 3098, Tulsa, Oklahoma • Telephone: WEbster 2-3242

CATAWISSA VALVE & FITTINGS CO.
CATAWISSA • PENNSYLVANIA



Type 'A' Time Cycle Pilot

A new Type "A" time cycle pilot is available with multi-clip timing wheel and micrometer adjustment screw for precision control. Provides supply gas signal time to less than 30 seconds, using a 24-hour clock, or less than 10 seconds using a 2-hour clock. Minimum time for a complete cycle using a 24-hour clock is 4 minutes. (Macco Oil Tool Co., Inc. Supplements data on Pages 3125-3127, 1958-1959 Composite Catalog.)

For more data, circle E20 on postcard

WHIP DOWNHOLE MILLING COSTS WITH KINZBACH SPEEDMILLS

TYPE 155

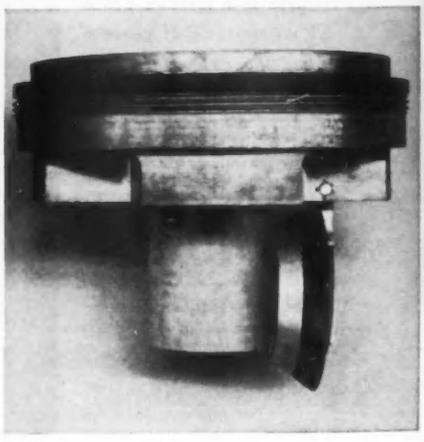
Continuously renewed multiple cutting edges, in optimum arrangement with tool shape, work contact areas, flushing passages, and other factors combine to make Kinzbach Speedmills highly efficient for downhole metal cutting operations.

Kinzbach Speedmills cut rapidly, leave clean work surfaces, and may be run under severe weight and speed conditions.

Types available for every downhole milling problem.

KINZBACH TOOL CO., INC.
P. O. Box 277 • HOUSTON, TEXAS
EXPORT: 74 TRINITY PLACE, NEW YORK, N. Y.

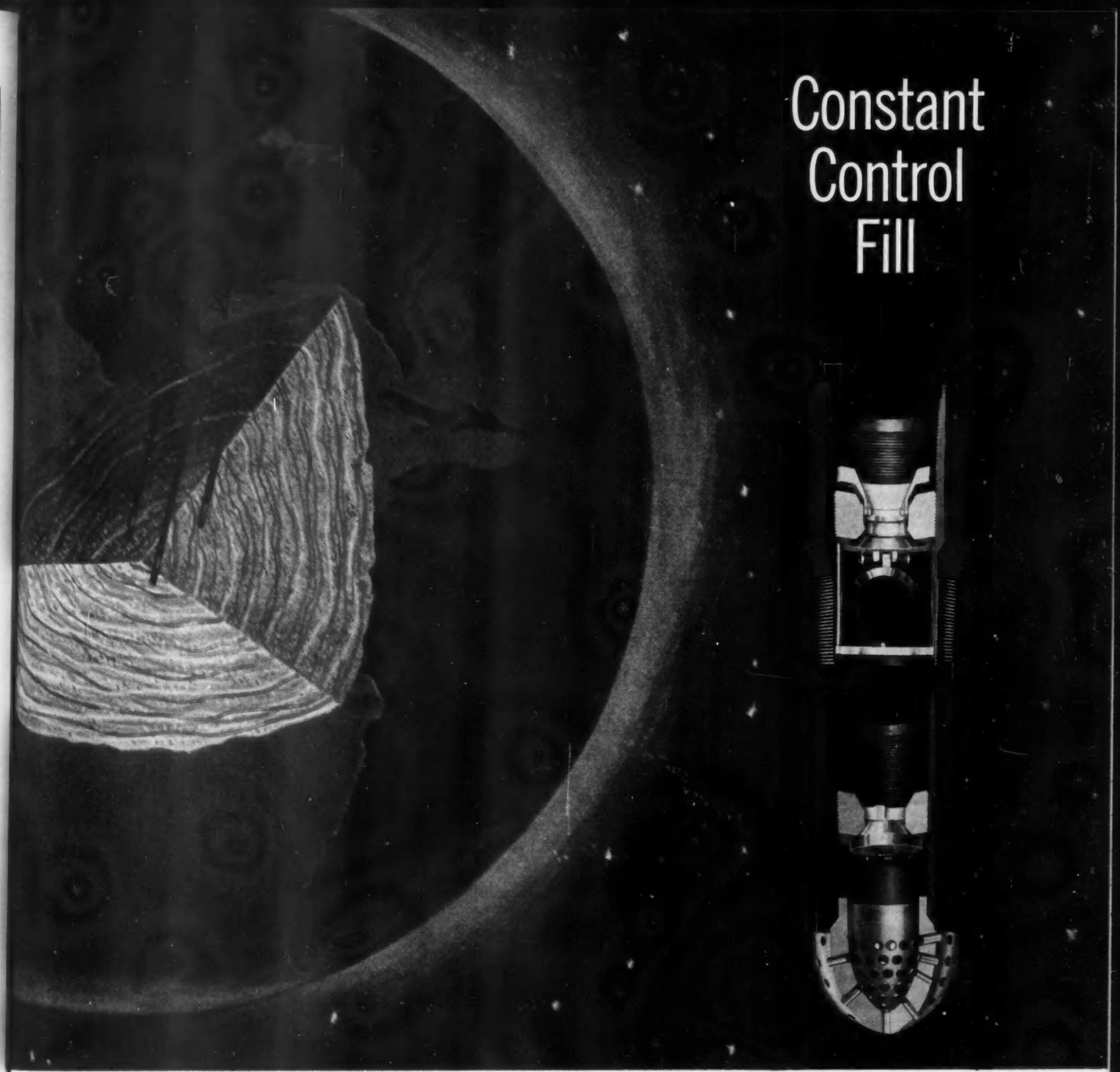
KINZBACH TOOL CO INC



Insert Float Valve

Designed to withstand pressures up to the collapse strength of J-55 casing in all weight ranges is this new insert float valve. Valve saves money with its drillable aluminum valve seat and saves time because of installation because it's inserted inside the pipe. One size body valve is required for weight ranges in its O.D. casing size. (Halliburton Oil Well Cementing Co. Supplements data on Pages 2177-2284, 1958-1959 Composite Catalog.)

For more data, circle E21 on postcard



RECORD BREAKING PERFORMANCE

Rector Type "O" Cementing Equipment insures constant control under all conditions

Rector Type "O" cementing equipment delivers outstanding performance with safety, proven in routine operations or at the end of the longest casing string ever run — 25,340 feet under the ground. Rector Type "O" is the ONLY automatic casing fill-up equipment that permits circulating the well at your option, then continuing to run pipe with controlled orifice fill from the bottom. A new ceramic choke that can be changed in the field is available for overcoming orifice wear from abrasive sands and insuring constantly controlled operation. A bullet shaped aluminum screening nose guides the shoe past ledges and obstructions. Tests prove that lost circulation materials of all kinds can be circulated through the perforated nose without danger of plugging.

Rector Type "O" fill shoes and fill collars are precision machined from high quality seamless steel. Internal parts are high strength aluminum alloy and can be easily drilled. Specify Rector equipment in your next cementing program. See your favorite supply store — or ask a Rector man for details.

PESA

Rector WELL EQUIPMENT CO., INC.

1100 No. Commerce St.
Fort Worth, Texas

Making the Oil Industry Safer

Houston plant: 2215 Commerce Street Export representatives: Continental Supply Co., Mid-Continent Supply Co., Oil Well Supply Co.

CUT STUCK SAND LINES INSIDE TUBING

KINLEY SAND LINE CUTTER

M. M. Kinley Company, Licensees

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BAY CITY, TEXAS—J. P. Graham.....CI 5-4528
CASPER, WYOMING—C. A. White.....3-5264
CORPUS CHRISTI, TEXAS
Tolle, Inc. .....TE 5-5367, UL 2-1711
GLENDIVE, MONTANA—C. A. White...EM 5-3833
HOBBS, NEW MEXICO
Horne Well Service Co. 3-5396
KILGORE, TEXAS
Davis-Kemp Tool Co., Inc. 5541
LIBERAL, KANSAS
Rainbo Service .....Main 4-3598
LINDSAY, OKLAHOMA
Rainbo Service Co. .....PL 8-2530
MIDLAND, TEXAS
Luceous Service & Equt. Co. .....MU 2-1631
OKLAHOMA CITY, OKLAHOMA
Rainbo Service Co. .....ME 4-2131, ME 4-0105
VIDALIA, LOUISIANA
Davis-Kemp Tool Co., Inc. 435
WHITTIER, CALIFORNIA
Kline Wire Line Co. .....OX 3-2731
WICHITA FALLS, TEXAS
Hudson-Eads, Inc. 322-8584
WILLISTON, N. DAKOTA
C. A. White .....GR 3-6555

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Heat and vibration-proof, non-solvent, will not shrink, crack or crumble. Makes all assemblies leak-proof and pressure-tight. Prevents rust, corrosion, joint seizure.

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The super-penetrating rust solvent

LOOSENS

rusted bolts, nuts, screws, 'frozen' parts

Liquid Wrench works *fast*...yet is absolutely safe for all metals and alloys.

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Charlotte, North Carolina

SOLDER SEAL

Literature

To get your copies, circle key numbers on postcard and mail to WORLD OIL

Sandpump Brochure

The Axelson Sandpump is described and illustrated in a brochure available through the Axelson Division, U. S. Industries, Inc. The 4-page, two-color brochure describes advantages gained by use of the new pump for production of wells containing an excessive amount of sand as well as other problem type wells.

For more data, circle E27 on postcard

'Screen Pipe' Bulletin

A new eight-page bulletin with illustrations of all of the types of screen pipe manufactured by Emsco Screen Pipe Company of Texas, Inc., is now available. A new method of arriving at price is also included.

For more data, circle E28 on postcard

Mobile Camp Bulletin

Rugged mobile camp structures for use in field operations are described in a new bulletin available from the S & R Tool and Supply Co. Construction details and interior arrangements of the different types of units are fully described in the four-page brochure.

For more data, circle E29 on postcard

New Bit Catalog

Oil Tool Manufacturing Co., Inc., has made available a new illustrated catalog of its entire line of bits, giving available sizes and specifications of all designs, recommended use of each and general plant information.

For more data, circle E30 on postcard

Rod Pump Bulletin

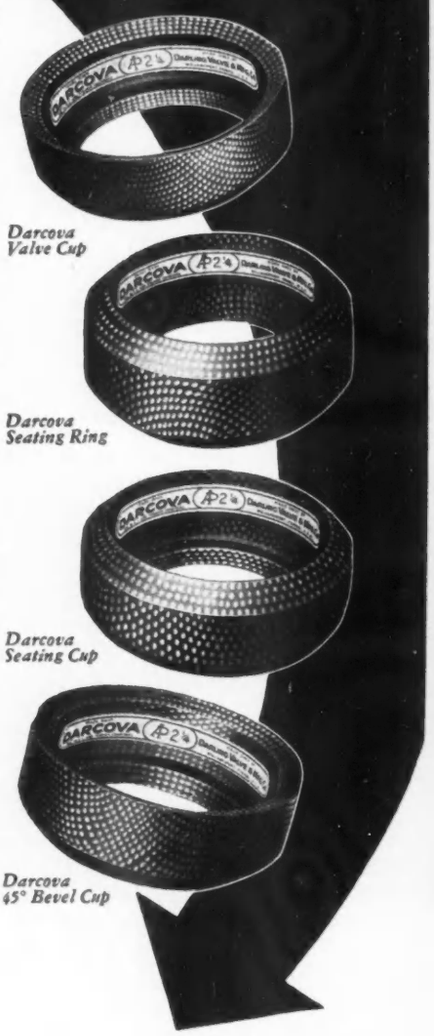
An illustrated bulletin on its deep-well "transportable" rod pump, designed for long-stroke pumping, has been published by Harbison-Fischer Mfg. Co. Included is a section on the heavy-duty Tuff-Tamper rod pump which has a double-thick, honed finished barrel tube that is induction heat-treated to produce a hardened wearing surface on the inside, yet outside is ductile and shock-resistant.

For more data, circle E31 on postcard

DARCOVA
now offers...

- MORE STRENGTH
- MORE LIFE
- MORE PERFORMANCE PER DOLLAR

with 100% NYLON COMPOSITION!



Darcova Valve Cup
Darcova Seating Ring
Darcova Seating Cup
Darcova 45° Bevel Cup

and *only* in DARCOVA can you get this time-saving, money-saving advantage! Available in the full range of sizes and Darcova textures for varying well conditions.

Send for Bulletin No. 5502
and specify DARCOVA at your supply store.
There *is* no substitute!

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DARCOVA®

THE ORIGINAL COMPOSITION CUP

WILLIAMSPORT 28, PA.

NO OTHER PACKING LASTS AS LONG

MARLO Polished Rod Packing is the most cost-cutting and long-lasting packing found in any oil field, anywhere.

RW-6E Sets for Round Stuffing Boxes

1 MARLO outlasts ordinary packing up to 8 and 10 times, and *more.*

2 MARLO saves oil, reduces wear on rods, saves labor.

3 MARLO does not harden or burn during pump-off.

4 MARLO is anti-frictional. Its resilient, corrosion-resistant, semi-metallic rings form a dense, shock-absorbing, bearing-like surface.

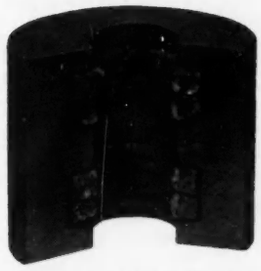
5 MARLO has been proved in the field and standardized on by more and more leading producers.

Available in all regular sizes

Available through any Supply Store you favor

MARLO IMPROVED PACKINGS FOR HERCULES AND RATIGAN STUFFING BOXES

with vitalizing, semi-metallic inserts. Immensely longer life under toughest conditions. The only truly modern designs. In all standard sizes.



For **HERCULES** Stuffing Boxes

For **RATIGAN** Stuffing Boxes

USI A **Axelson**

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Reduce Corrosion* In Storage Tanks

Eliminate Gravity Drop
Minimize Vapor Losses
Cut Lifting Costs

With Enardo Thief Hatches

*Corrosion in storage tanks is greatly reduced when oxygen is excluded and correct pressure setting is maintained on all tanks in a battery.

The Enardo by-pass thief hatch is a combination hatch, vacuum and pressure valve, and by-pass valve. When the hatch is opened on one tank, the by-pass closes the opening into the vent line, sealing off the rest of the tanks in the battery. This automatically holds the correct pressure settings in the other tanks and excludes oxygen . . . preventing large gravity and volume losses during normal operations and reducing tank corrosion.

Available in dead-weight or spring-loaded types . . . with or without by-pass . . . pressures from 2 to 80 oz.

Find out today how Enardo Vapor Control Equipment can substantially increase your profits. Write for free catalog.

ENARDO Box 1647, Tulsa, Okla.

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FOR OIL COUNTRY USE

LINE PIPE COUPLINGS A. P. I.
1/8" to 12"—Seamless, Black or Galvanized
PLAIN TUBING COUPLINGS A. P. I.
1" to 4"—Seamless
EXTERNAL UPSET TUBING COUPLINGS A. P. I.
3/4" to 3 1/2"—Seamless
CASING COUPLINGS A. P. I.
4 1/2" to 13 3/8"—Long or Short
HYDRAULIC COUPLINGS
1/8" to 4"—Seamless
REAMED AND DRIFTED A. I. S. I.
3/4" to 12"—Seamless
DRIVE PIPE COUPLINGS
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All Sizes and Types
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IDECO-WOODFIELD
SHORTY
BLOCKS
WITH
FABRIFORM SHEAVES

★ Individually lubricated tapered bearings.
★ Cases are fabricated from plate steel.
★ Hinged sheave guards for faster reeving.
★ Safer, streamlined case; low centre of gravity.
★ Compact design gives up to 9 feet more headroom.
★ Tapered bearings keep sheaves in positive alignment.
★ Unitized block has automatic safety lock on hook and patented hydraulic metering device to give jarless stop in upward movement.

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Mud Acid Technical Report

Dowell Division of the Dow Chemical Company has published a technical report on its Mud Acid. Mud Acid, as the report is named, describes Mud Acid chemically, lists its uses, summarizes the several methods of treating wells with Mud Acid, provides laboratory data and shows results obtained by using Mud Acid.

For more data, circle E32 on postcard

Conversion Chart

A reference table for engineers and other executives in wall chart form has been published by Precision Equipment Company. Included are common conversions such as inches to centimeters or watts to hp, and conversions difficult to locate in reference manuals.

For more data, circle E33 on postcard

Warning Signs Catalog

California Metal Enameling Company has a color catalog illustrating their complete line of warning signs. Included are 65 Danger worded signs, 16 Caution signs and 62 miscellaneous warning signs. Special section on reflectorized stock traffic signs for refining yards is included with prices.

For more data, circle E34 on postcard

Line Shaft Pump Bulletin

A technical bulletin has been issued by Peerless Pump Division, Food Machinery and Chemical Corporation, on their line shaft pumps capable of providing 15,000 bpd of flood water from wells down to 1,500 feet. Line shaft pumps are suited for operation with all types of drives—electric or right angle gear or combination of the two.

For more data, circle E35 on postcard

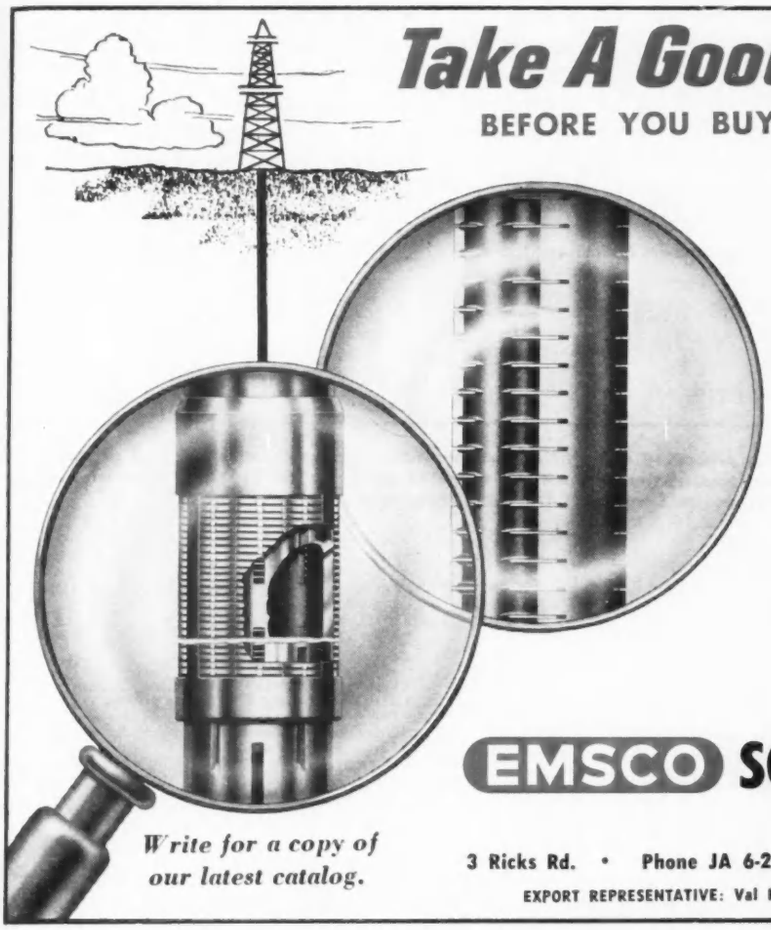
Spectral Log Bulletin

A technical bulletin on the new Special Log, giving comprehensive data, illustrated with charts and logs is available from Perforating Guns Atlas Corporation. Bulletin states accomplishments of the Spectral Log in a series of recent field tests.

For more data, circle E36 on postcard

Take A Good Look...

BEFORE YOU BUY SCREEN PIPE !



Once a well is completed, the thing next to the hole in importance is the selection of the best Screen Pipe available. Here are the facts about EMSCO Screen Pipe.

EMSCO Wire Wrapped Screen with vertical slots provides 50% to 60% more opening per foot than conventionally drilled holes. It retains more tensile strength than drilled pipe.

EMSCO Slotted Screen Pipe retains up to 85% of the original collapsing strength of the pipe. It is smooth, facilitating setting and pulling. It can be reasonably spudded or rotated without fear of damage. Internal "V" slots promote drainage, retard clogging.

Write for a copy of our latest catalog.

EMSCO SCREEN PIPE COMPANY
OF TEXAS, INC.

3 Ricks Rd. • Phone JA 6-2609 • P. O. Box 14446 • Houston 21, Texas

EXPORT REPRESENTATIVE: Val R. Wittich, Inc., 30 Rockefeller Plaza, New York 20, N. Y.

ANOTHER FIRST from Foster

DOUBLE GRIP TONGS

HOLDS ONE SECTION AS IT TURNS THE OTHER

Foster power tongs are the only tongs to offer a backup wrench for holding the lower section of pipe while the tong turns the upper section. Foster backup wrenches have forever whipped the problem of power tongs turning your pipe in the slips.

Only on Foster Power Tongs (the tongs that stay on the pipe) is such a backup wrench possible.

All Foster Representatives carry a complete inventory of spare parts for Foster tongs and all models of Foster Catheads.

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Peck Sales & Service	Houston, Texas
Tillery & Parks	Odessa, Texas
Garlick Sales & Service	Oklahoma City, Oklahoma
Texas Warehouse Service	Corpus Christi, Texas
R. D. Cloninger	Lafayette, Louisiana
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W. O. Nelson	Farmington, New Mexico
Coastal Engineering Co.	Bakersfield, California
Moore Sales & Service Company	Casper, Wyoming
Joe Perry	Salem, Illinois
T. C. McDonald	Shreveport, La.
Leidecker Tool Co. Ltd.	Edmonton, Alberta, Canada
Langley Y Cia. Srl.	Buenos Aires, Argentina
East-West Oil Tools C. A.	Maracaibo & Anaco, Venezuela
Rooks Oilfield & Engr. Supply Ltd.	San Fernando, Trinidad, T.W.I.

Foster CATHEAD COMPANY
P. O. BOX 1351 WICHITA FALLS, TEXAS
2101 GRANT ST. PHONE 322-8653

Flame Arrestor Literature

An 8-page pamphlet describing the National Flame Arrestors, available in two types for installation on all existing fired production units, has been released by National Tank Company. Complete description and photographs are also included.

For more data, circle E37 on postcard

Transfer Pump Catalog

A close-coupled petrochemical and cryogenic transfer pump, designed for high-flow continuous or intermittent duty for any fluid, is described in an illustrated catalog sheet by Turbocraft, Inc. Catalog sheet reproduces performance data in chart form.

For more data, circle E38 on postcard

Compressor Bulletin

A 12-page bulletin on the Cooper-Bessemer Series Turbocharged Type GMXC compressor is available from the Cooper-Bessemer Corporation. Bulletin 90 describes construction details on 9¾-inch bore by 10½-inch stroke V-angle compressor units.

For more data, circle E39 on postcard

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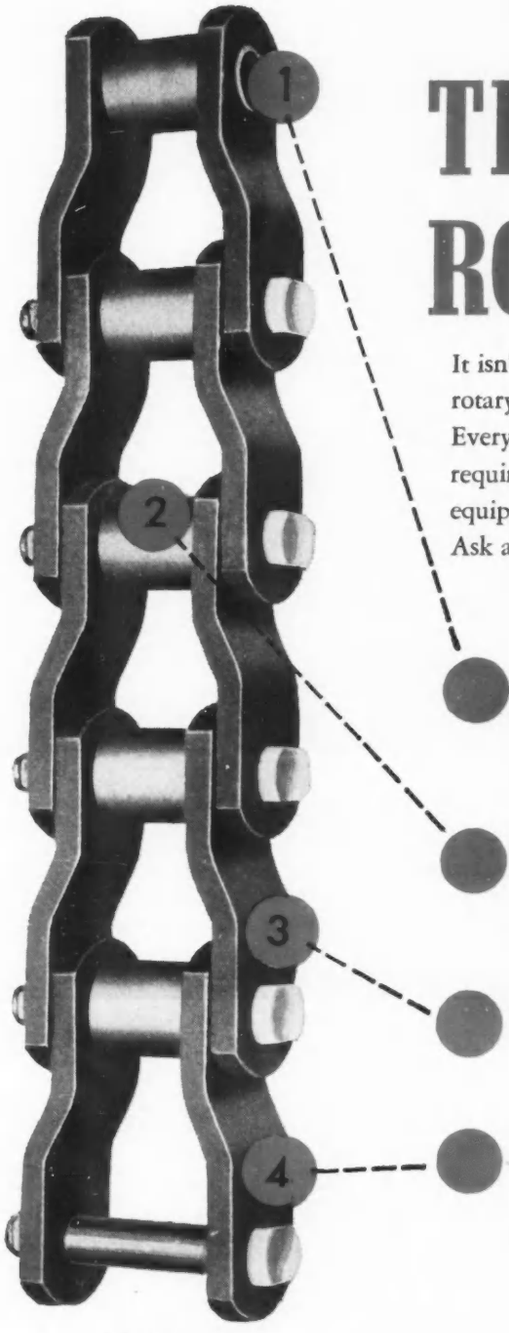
Link-Belt SS-40 Hyper

THE LONG LIFE ROTARY CHAIN

It isn't chance that delivers the kind of chain you need for high rotary speeds — it's advanced engineering and manufacture. Every piece of Link-Belt A. P. I. Chain is built to meet these requirements. All the facts on this chain and other Link-Belt equipment for the oil field are contained in our Book 2880. Ask any leading supply store for your copy.



SS-40 Hyper
A. P. I. 3.

BUSHINGS Machined alloy steel — case hardened for greatest wear resistance — ground internally and externally to precision accuracy.

ROLLERS Alloy steel — heat treated for maximum wear resistance; shot peened for greater fatigue life; close tolerances for smooth, easy movement.

PINS Forged alloy steel, precision ground, cadmium plated.

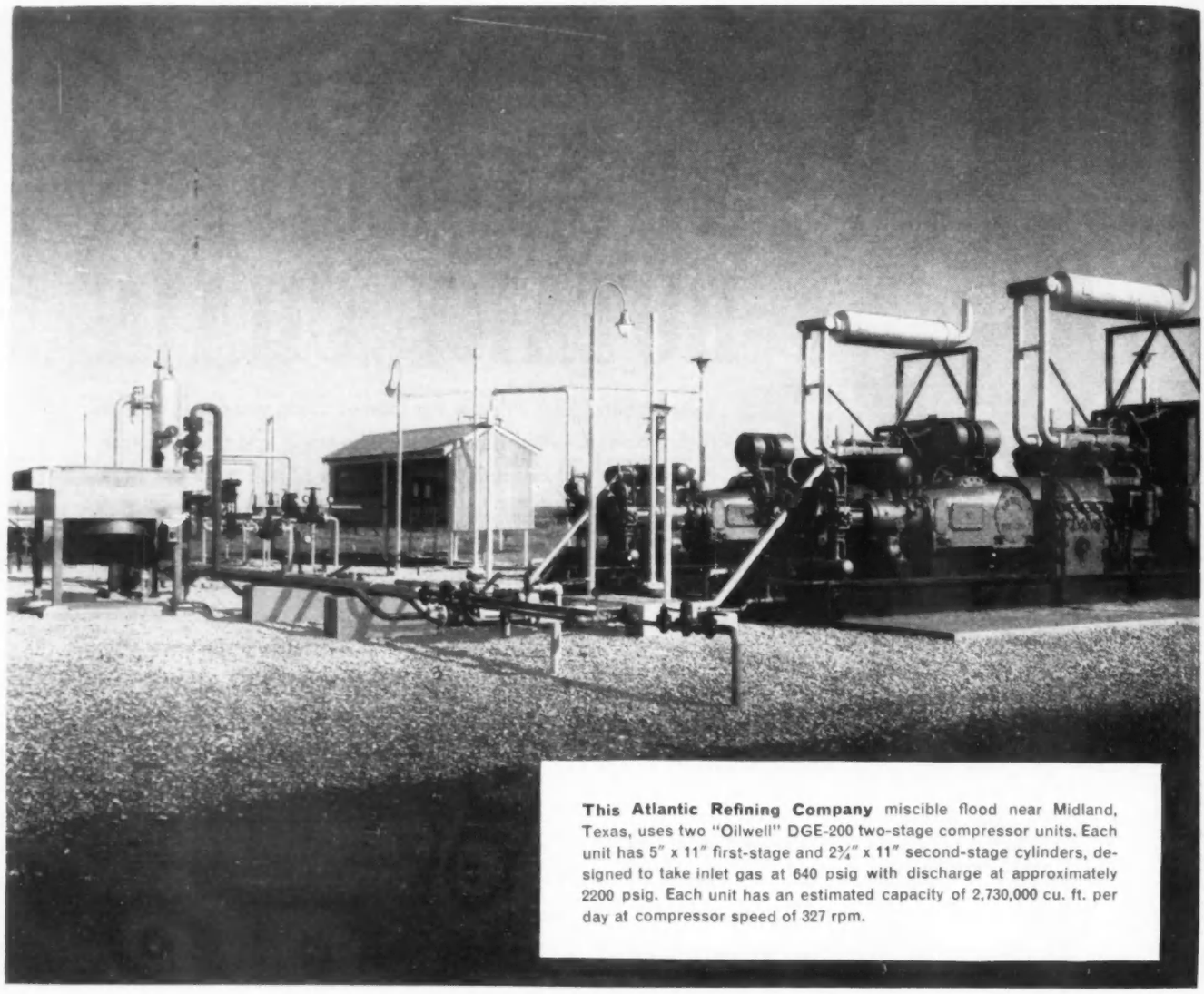
SIDEBARS Selected alloy steel — heat treated. Pitch holes finished to precision limits with size and pitch accurately controlled.

LINK-BELT COMPANY

Indianapolis 6, Houston 1, Dallas 26, Odessa, Tex., New Orleans 16, Shreveport, La., Los Angeles 22 (Montebello), Scarboro (Toronto 13); Export Office, New York 7. Distributors in All Fields. 15,012

LINK-BELT

CHAINS and SPROCKETS



This Atlantic Refining Company miscible flood near Midland, Texas, uses two "Oilwell" DGE-200 two-stage compressor units. Each unit has 5" x 11" first-stage and 2¾" x 11" second-stage cylinders, designed to take inlet gas at 640 psig with discharge at approximately 2200 psig. Each unit has an estimated capacity of 2,730,000 cu. ft. per day at compressor speed of 327 rpm.

"Oilwell" High-Pressure Compressors for miscible flood applications

"Oilwell" DGE high-pressure gas compressors are specially designed for full-load operation. Relatively slow operating speeds throughout their size range from 125 to 300 hp, keep wear at a minimum, with correspondingly reduced maintenance costs.

Duplex compressors with special tandem-type cylinders are mounted side by side and driven by a single gas engine through right-angle gearing. Everything, including controls and piping, is mounted on a single skid base. Fully enclosed weatherproof construction enables these units to operate unprotected, except where weather conditions are severe.

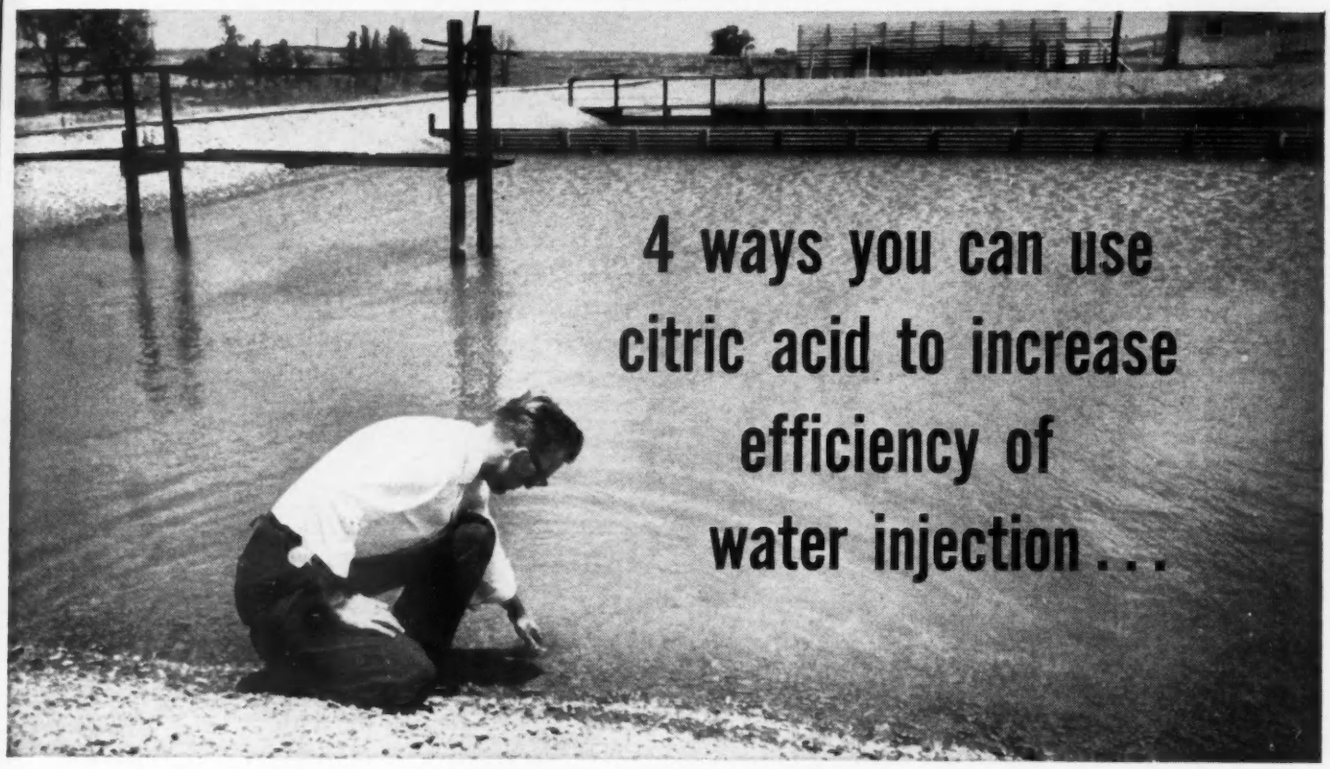
For all kinds of gas pumping operations, contact your nearest "Oilwell" store or write COMPRESSOR DEPARTMENT, Oil Well Supply, Dallas 21, Texas . . . and get the latest information on DGE units in this size range, specifically designed and equipped for your application.

USS and "Oilwell" are registered trademarks

USS Oil Well Supply Division of United States Steel

Executive Offices—Dallas, Texas Export Office—30 Rockefeller Plaza, New York 20, N. Y.

Iron is probably the most serious cause of plugging problems at three out of five water flood projects . . .



The success of citric acid in increasing water injection efficiency has been proved in four distinct types of applications. Variations in water quality and operating conditions will determine which application you should use. In each case, citric acid sequesters iron in your injection water, prevents the serious plugging action of iron precipitates.

1. Maintenance Treatment entails the constant addition of citric acid (3:1 or 4:1 ratios of citric to iron content) to prevent iron from filtering out on the sand into which the water is injected. This, of course, helps to maintain high injection rates at normal pressures. For best results in maintenance treatment with citric acid, a water injection plant should be operating at optimum injection rates and pressures.

Two salt water disposal wells in southern Texas, with average injection rates of 200 to 400 barrels per day showed a 30 percent increase in injection shortly after only 8 ppm addition of citric acid was started as maintenance treatment.

2 & 3. Acidizing and Detergent Treatments are very important adjuncts to successful maintenance treatment. When iron plugging the sandface has already caused lowered rates and/or high pressures, acidizing with citric and hydrochloric acids or cleaning with detergents plus citric acid are excellent methods for returning the injection wells to optimum conditions.

A well in Oklahoma showed marked improvement after acidizing with a solution of 260 pounds citric acid, 25 gallons Triton* X-100, 250 gallons 15% hydrochloric acid and 500 gallons water. The injectivity index rose to 195 bbl./day/ft. of pay from 3 bbl./day/ft. of pay. Gradual decline was noted over a short period, but the index leveled at 80 bbl./day/ft. of pay.

4. Slug Treatment with citric acid is designed for those systems where the water contains iron which cannot be economically treated to keep the iron in solution, or for those systems where the iron is completely precipitated before the water can be treated. Slug treatment at 500 ppm once every 4 to 6 weeks sufficiently lowers the pH to dissolve much of the insoluble iron, and the cost of treatment is low when averaged over this period of time.

A well in southern Louisiana was treated by slugging with two 400-pound batches of citric acid, two weeks apart. Injection rates have more than doubled, from 4,000 to 8,640 barrels per day, at last report, and in addition, the pressure has averaged 300 psi lower than previous requirements.

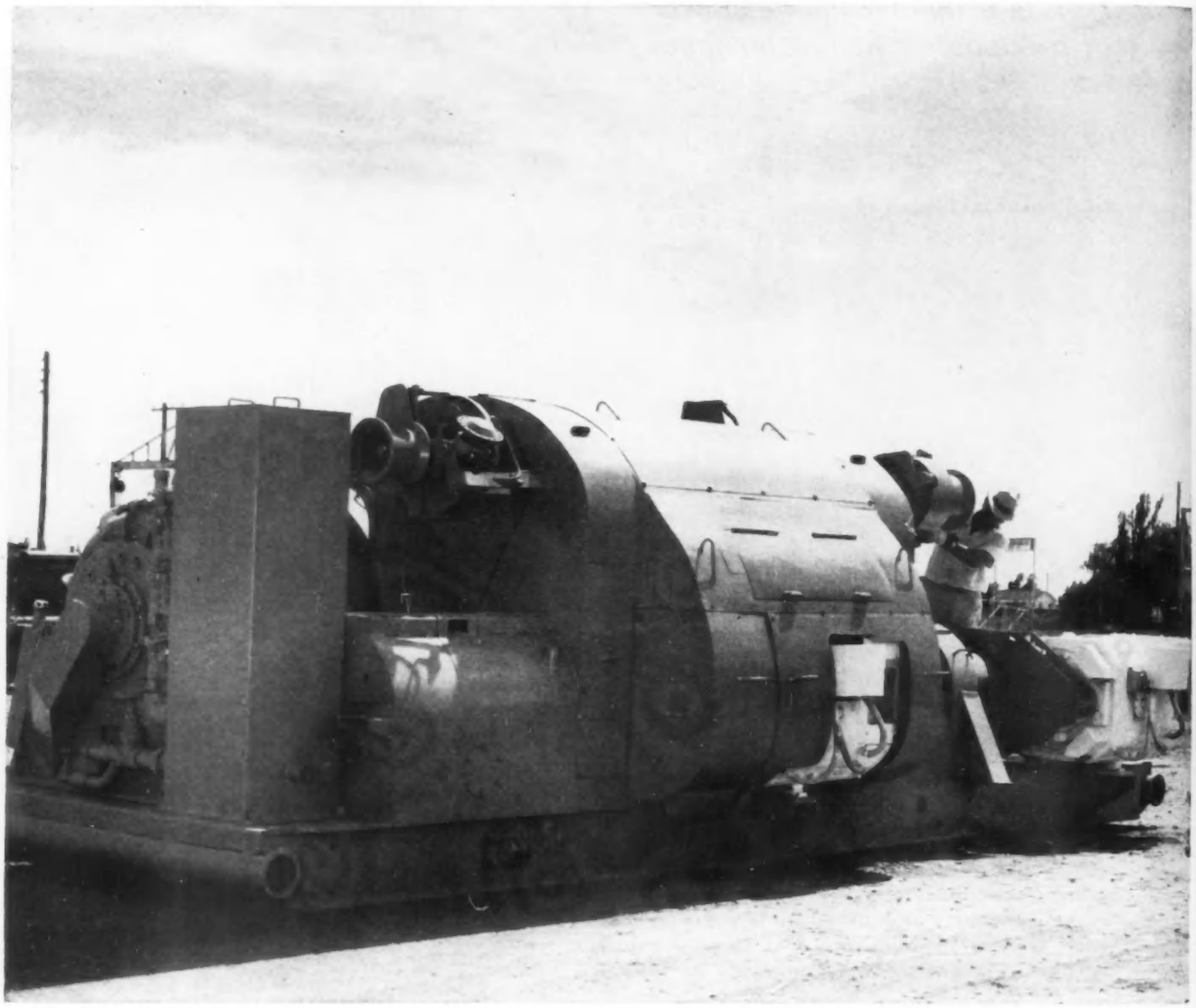
Other operators have noted good results because of less frequent downtime on filters, and less replacement of parts because of rusting. If water flooding is your business, and you would like complete information on the use of citric acid for iron sequestering, write the Pfizer Chemical Sales Division today.

*registered trademark Rohm & Haas Company

Science for the World's Well-Being

Pfizer

CHAS. PFIZER & CO., INC.
Chemical Sales Division
630 Flushing Ave., Brooklyn 6, N.Y.
Branch Offices: Clifton, N. J.; Chicago, Ill.; San Francisco, Calif.; Vernon, Calif.; Atlanta, Ga.; Dallas, Texas



"Oilwell" 96 Draw Works with 2000 hp built-in electric drive

The unique conversion pictured above enabled a prominent "Oilwell" 96 user to change his standard 96 draw works to ultra-modern electric drive.

This rear draw works view shows the compact installation of two duplicate 1000 hp direct-current gear-motors. One motor, coupled to the high and clutched to the low drive shaft, rests in the center compartment formerly occupied by the independent transmission, while the other motor at right is coupled to the low drive shaft. There is no increase in draw works width with only a 4'6" extension at the driller's end.

The arrangement provides maximum flexibility and a wide speed-torque range for hoisting, rotating, or a combination of both. Pumps on the rig have independent motor drives.

This is another example of how our modern facilities and engineering experience combine to give "Oilwell" customers what they want.

USS and "Oilwell" are registered trademarks

USS Oil Well Supply Division of United States Steel

Executive Offices—Dallas, Texas
Export Office—30 Rockefeller Plaza, New York 20, N. Y.

Cat No. 977 Traxcavator loads "a truck a minute"

—6 yards of caliche every 60 seconds!

Near Dawson County, Texas, the Globe Construction Company used caliche, graded and compacted, to form a 6″ top surface for the site of an oil drilling location. In addition to the "pad," a ¼-mile road 12′ wide was also surfaced with the same material.

Needed were 900 yards of caliche from a pit 3 miles away. A Cat No. 977 Traxcavator, working with seven 6-yard trucks, completed the job in just seven hours, starting at 8:30 in the morning and finishing up by 3:30 in the afternoon.

The No. 977 loaded at the rate of *one truck every minute.*

Says owner, J. O. Williams: "Caterpillar makes the kind of machine our work needs and demands. They are always reliable."

Among the outstanding features of the No. 977 is the large-capacity 2¼ cu. yd. bucket . . . exclusive long-life oil clutch . . . direct electric starting of the 100 HP engine . . . excellent control response and balance in tight quarters.

Traxcavators are high work producers under any conditions. You see them wherever work has to be done fast. They're built for tough operating conditions with a heavy steel main frame welded into a one-piece unit. The box construction track roller frame absorbs loads and stresses.

You'll find there's a versatile Traxcavator for your operation. Besides the No. 977, the No. 955 has a 1½ cu. yd. bucket, the No. 933 has 1⅛ cu. yd. bucket. Each model has a complete selection of specialized buckets, including the exclusive side dump. Let your Caterpillar Dealer help you choose the Traxcavator best suited for your job. Call him for an on-the-job demonstration soon.

Now an even tougher No. 977 Recent improvements in this modern, heavy-duty machine include the following for Series D models: New track link for greater strength and longer wear. Optional hydraulic track adjusters for easier adjustment of track tension.

For Series E: New lifetime lubricated rollers and idlers that require no further servicing until rebuilding. New triple grouser track shoes that provide good traction in soft material, have low turning resistance and longer life.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR

Caterpillar, Cat and Traxcavator are Registered Trademarks of Caterpillar Tractor Co.

FOR FAST LOADING

NATIONAL'S Revolutionary MANI-FLO® VALVE

PATENT APPLIED FOR

The MANI-FLO valve, through unique design, lends itself to wide use in the production of oil and gas. Designed primarily for use in lease well production manifolds to eliminate the problems and expenses of conventional arrangements consisting of cumbersome piping, standard valves and fittings, it may also be used as a three-way valve for blending two streams for temperature control; for mixing two different liquids or gases; or as a switching valve to divert flow to different tanks or lines.

In any role or application, MANI-FLO valves may be hydraulically, electrically or diaphragm controlled and sensed by liquid levels, pressures, temperatures, times or differentials of these.

MANI-FLO valves may be installed in a horizontal line with diaphragms and/or handwheels either vertically or horizontally, or valves may be stacked vertically from ground up with controls pointing in any direction.

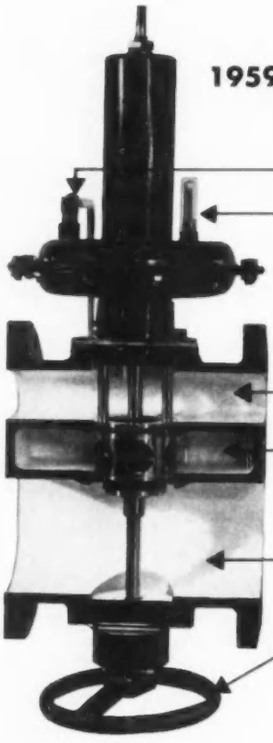
TYPICAL SPECIFICATIONS:

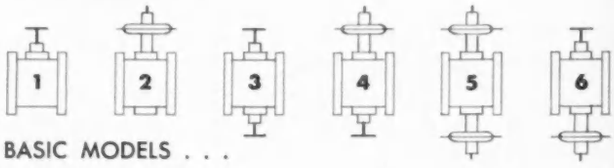
SIZE: 2" screwed inlet — 2" test outlet — 4" flow outlet — ½" sample connection opposite 2" inlet.

WORKING PRESSURE: 600 PSI. Test Pressure 1200 PSI.

MATERIAL: Body and Body Cover Flanges — Ductile Iron. Diaphragm Case — Pressed Steel. Plug, Seat and Cage — Type 303 Stainless Steel. Plug has Buna N synthetic rubber molded to 303 to give same sealing characteristics as "O" ring for tight shut-off. Metal-to-metal contact between plug and seat to prevent extrusion of rubber and to take excess force applied to seat and plug when closed.

1959 Oil Show Exhibit
MODEL 4

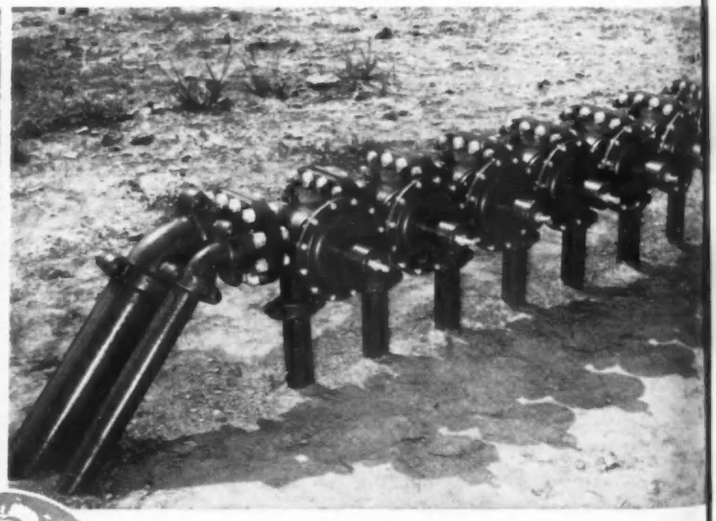

DIAPHRAGM SUPPLY PRESSURE
TRAVEL INDICATOR (UP indicates fluid to flow line . . . test line closed)
UPPER 2" TEST CHAMBER
INLET AND SAMPLE CHAMBER
LOWER 4" FLOW
Hardwheel on Bottom for changing Plug & Seat



BASIC MODELS . . .

FACTS:

- COMPACT . . . less space required for complete manifolds
- EXPANSIBLE . . . add a well — add a MANI-FLO
- VERSATILE . . . for line pressures 600 PSI or less:
  a. May be used as a shut-in valve
  b. Six different models for various applications to choose from
- PRACTICAL . . . travel indicator or positive flag
- SALVABLE . . . bolt it in or un-bolt it
- LONG-LASTING SAFETY . . . ductile iron bodies with stainless trim, tested to 3,000 PSI
- ACCEPTED AND APPROVED . . . hundreds in use already
- LOOKS THE PART . . . Judge for Yourself!



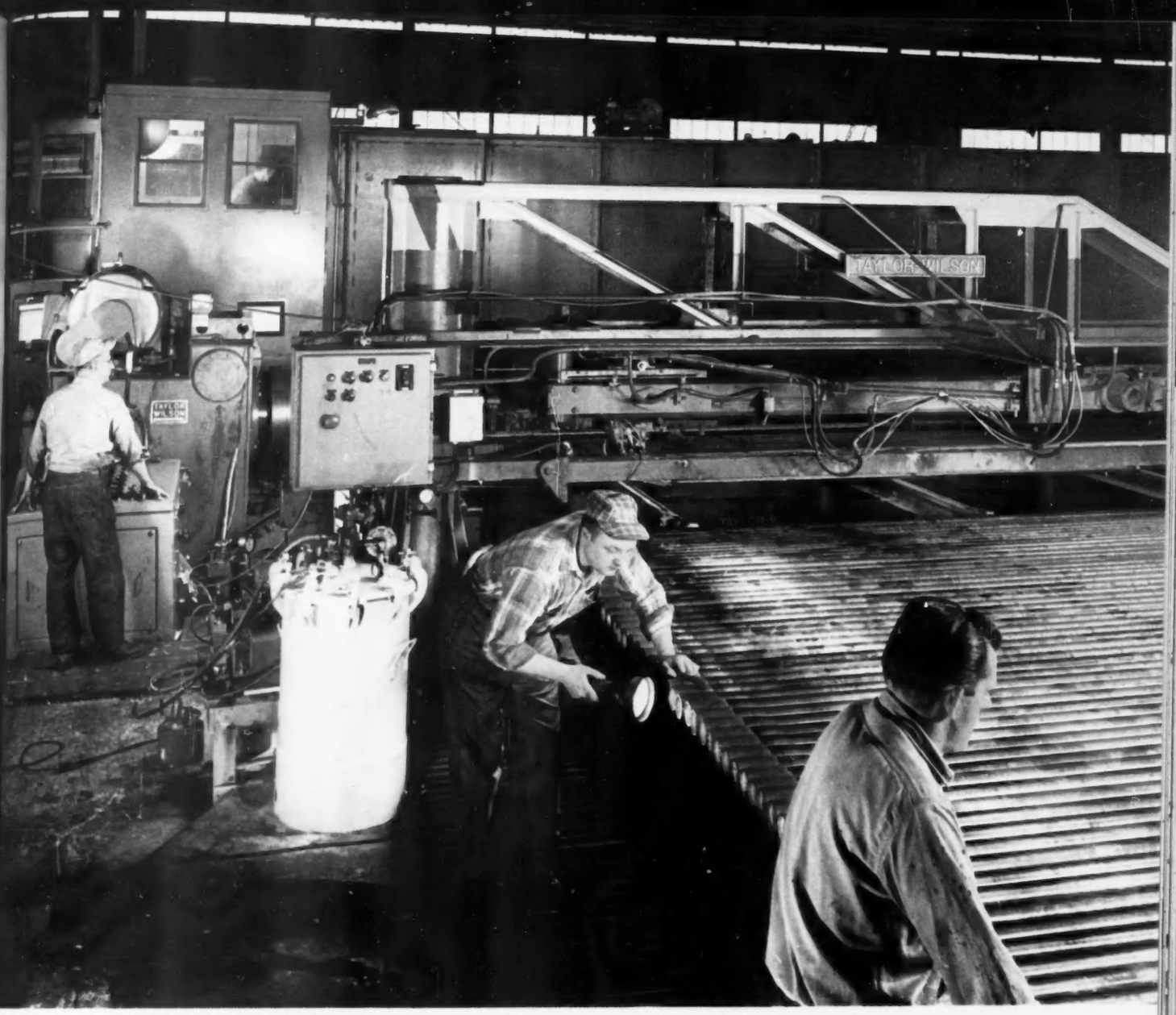
For prices and more information, state model number and quantity. Address . . .

It's a National®

NATIONAL TANK COMPANY

DRAWER 1710

TULSA, OKLAHOMA



New 15,000 psi tester includes automatic equipment for blowing out scale and dirt, stenciling, screwing on couplings, delivering pipe to tester, weighing after testing, screwing on thread protectors and spraying each length with oil.

SPANG's new pipe tester is unique

THE NATIONAL NSCO SUPPLY COMPANY

You can't produce the best quality tubular goods with ordinary facilities. So you obtain the best facilities available—even if, in some cases, the equipment is unique.

This new hydrostatic tester is such a facility. Added in our Ambridge, Pa. plant early this year, it's the only line production machine of its kind designed for a 15,000 psi pressure. It handles pipe up to 5½ in. O.D. and up to 48 ft. long, including plain end, threaded, coupled and upset pipe.

Modern facilities like this new tester insure the quality you always expect and get in Spang Tubular Products.

More on the next page—

DRAWER 1710
TULSA, OKLAHOMA

Three points to remember when you buy drill pipe

1. A SPANG drilling string is a fully integrated string

National Supply is the only company in the industry manufacturing both the drill pipe and the tool joints. From this *single* responsible source, you get a string that has carefully controlled quality from start to finish.

2. SPANG leads in tool joint design—the critical area of pipe service life

Spangweld Tool Joints are welded to the drill pipe by an automatically controlled operation insuring accurate alignment and a high quality weld. The welding permits a streamlined contour and a reduced number of threaded elements. This tool joint connection also allows the smallest practical O.D. and maximum bore—a definite advantage for slim hole drilling.

Spang Double Seal Shrink Thread Tool Joints can be easily removed and replaced in the field. Joint design has an outer seal, threads and inner seal all on a single cone. This insures uniform, reliable installations both at the mill and in the field, and completely seals against internal and external pressures.

3. SPANG provides the best selective protection against corrosion and abrasion

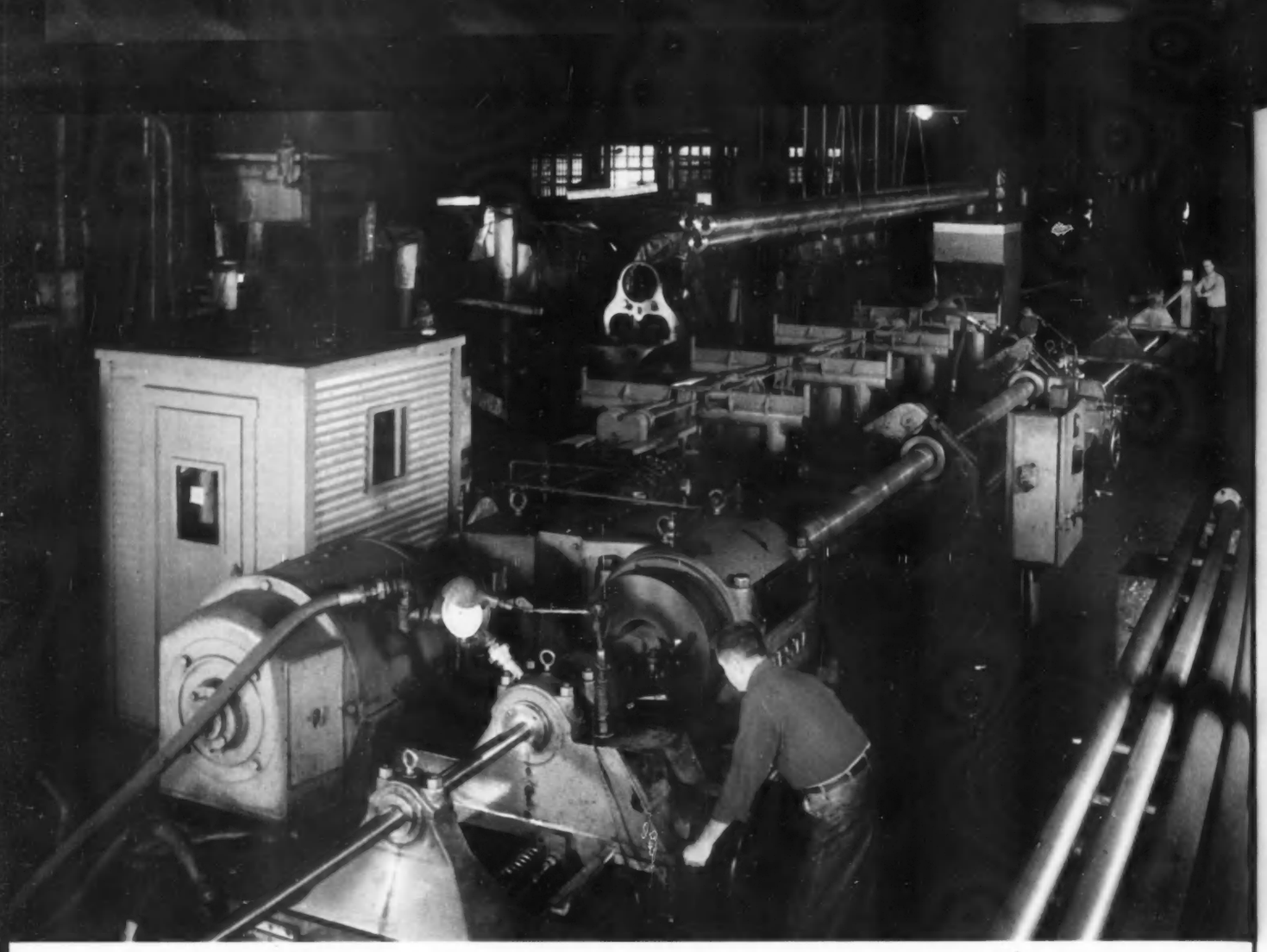
Spang Plastic Coating—the result of ten years of research—gives the best protection against corrosion. Scientifically applied at the mill on specially-developed facilities, Spang Plastic Coating is available not only in Spang Drill Pipe but also Spang Casing, Tubing and Line Pipe.

Spang Hardfacing is a superior protection for tool joints in abrasive formations. It consists of multiple bands of tungsten carbide, *continuously* overlapped on the joint to form a solid particle-to-metal band.

Specific proof of these benefits is furnished every day in numerous locations throughout the world. The National representative in your area will be pleased to tell you more.

A National plant inspector checks the destination of an order of hardfaced Spangweld Drill Pipe. Spang Hardfacing consists of multiple bands of tungsten carbide, continuously overlapped on the joint to form a solid particle-to-metal band.

National Drill Collars on the next page . . .



National Drill Collars are simultaneously bored from both ends on this 165-ft. trepanning lathe designed especially for this purpose. The lathe's speed and accuracy obsolete the ordinary type of solid bar drilling.

Use precision-made National Collars for best penetration rates!

Are you looking for ways to improve penetration rates at all drilling speeds, and extend the life of your drill string? Specify National Drill Collars and you'll see new results because of these features:

High strength properties—National Collars are made from alloy steel, hardened and tempered *full length* (not just ends only) for high strength. As an additional safeguard against fatigue failure, National "Tuf-Flexes" its drill collar joints by cold-rolling or peening.

True center bores—These are established by a special 165-ft. trepanning lathe which precisely bores both ends of the collar simultaneously. All bores are carefully surveyed for concentricity to insure proper balance while rotating at normal and high drilling speeds.

Stress relief grooving—To improve the fatigue resistance of drill collar joints, National machines a stress relief groove at the last engaged thread zone of both box and pin members. The pin relief groove is designed to protect the shoulder corner as well as the stress concentrating zone at the last engaged thread.

Along with performace records, features like these are proof that you can't buy a better drill collar than National's. So get the best—and the operating benefits that go with it. See a National representative about the drill collar sizes to meet your needs. He can also give you some valuable tips on collar care and handling.

Replaceable End Collars

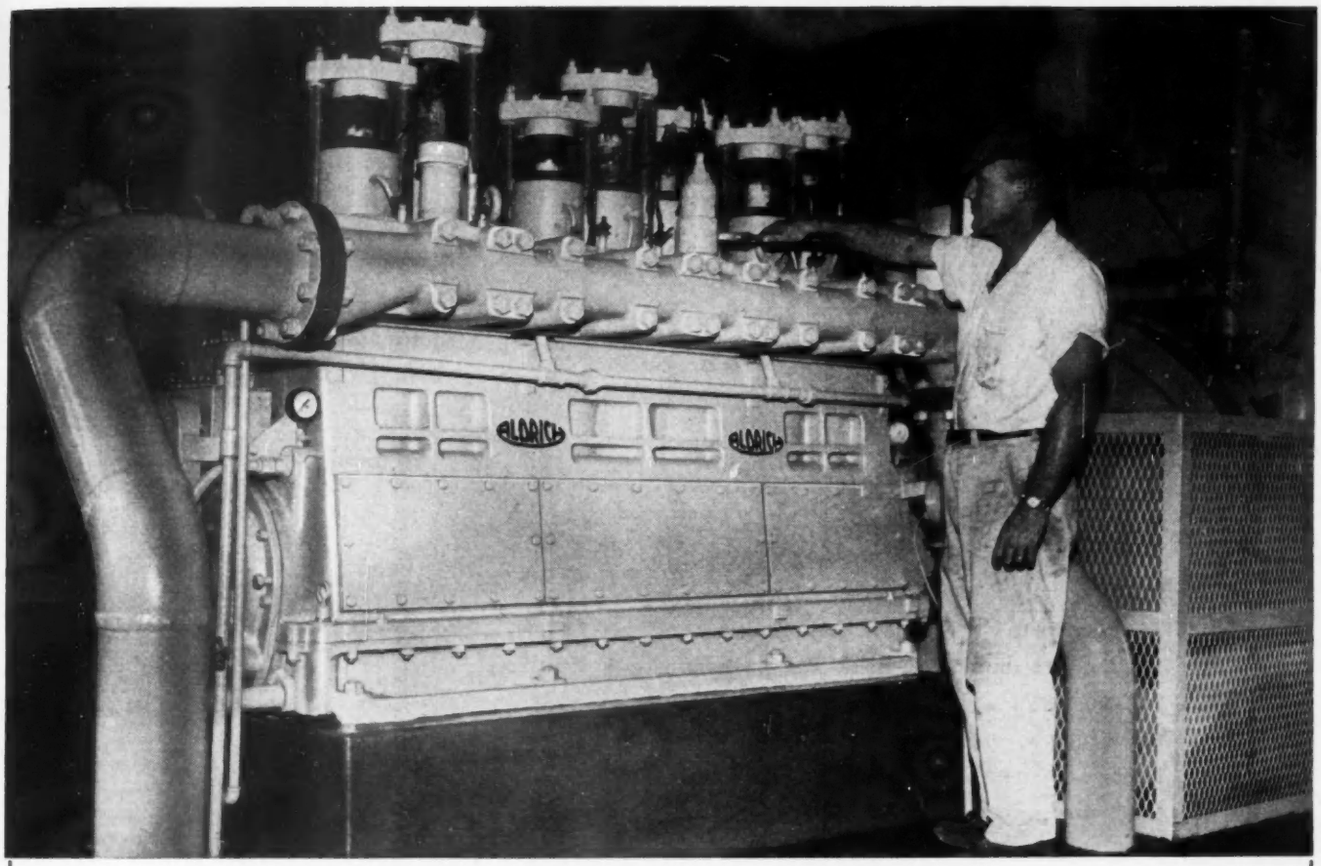
National also manufactures a complete line of drill collars with replaceable ends—incorporating a modification of the time-tested double seal shrink thread principle—for use in isolated areas where field shop facilities may not be available.

THE NATIONAL SUPPLY COMPANY

Subsidiary of Armco Steel Corporation

TWO GATEWAY CENTER, PITTSBURGH, PA.

DIVISION OFFICES: Calgary, Columbus, Dallas, Denver, Houston, Torrance, Tulsa
EXPORT: 600 Fifth Avenue, New York 20, N.Y., U.S.A.; City Wall House, Chiswell Street, London E.C. 1



FIELD REPORT

FLOOD: Pegasus Unit
OPERATOR: Mobil Oil Company
PUMPS: Two Aldrich Septuplex
FLOODING STARTED: February, 1955
EXPERIENCE TO DATE:

Pumps continuously deliver brine to two formations — 90 gpm at 2,500 psi; 150 gpm at 1,000 psi. Customer reports: "Routine maintenance only. Aldrich pumps were selected because of previous dependable and economical service under high pressure operations."

Field parts stock available in Carmi, Ill.; Calgary; Casper, Wyoming; Charleston, W. Va.; Houston; Los Angeles; Odessa and Tulsa. For further information, write the ALDRICH PUMP COMPANY, 4 Gordon Street, Allentown, Pa.

the toughest pumping problems go to ALDRICH

FOR PRACTICAL DUAL STRING COMPLETIONS

COMPARE THE SIMPLICITY, convenience and dependability of Baker Snap-Set Dual Packers with packers that depend on elaborate seals, valves and other intricate mechanisms.

Baker Snap-Set Dual Packers are easier to set than the simplest of hook-wall packers—just set down a slight amount of weight on the tubing to pack-off, simply pickup to release. They can be set and released as many times as desired without rotation, ball dropping or pressuring.

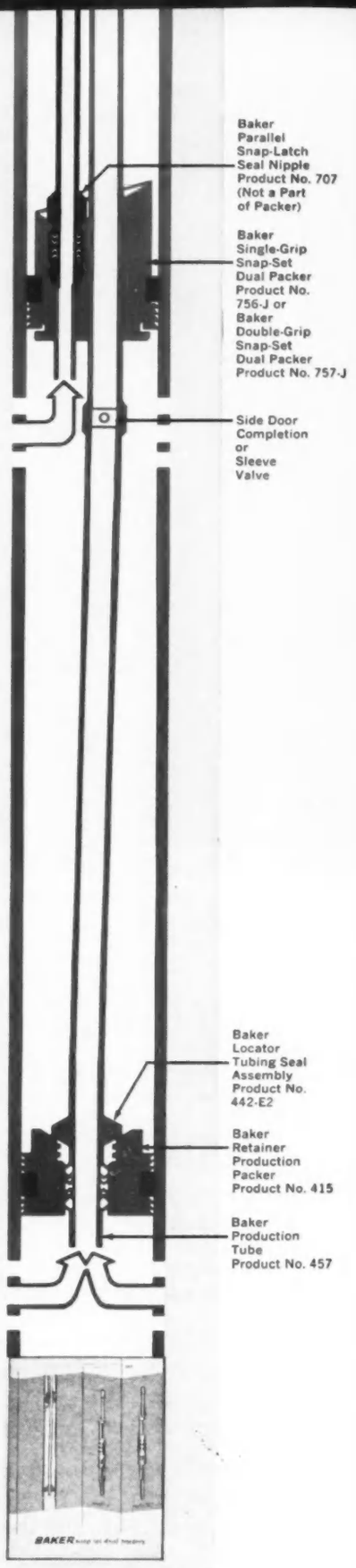
Baker Snap-Set Dual Packers offer full-opening through both sides for two strings of 2⅜" tubing when run in the popular 7" casing.

The Baker Model "J" Snap-Set Dual Packer is the ideal upper packer in a practical two-packer parallel string hookup, such as shown in the schematic at right. This hookup allows zones to be unloaded and washed after the well head is flanged up. Note that the vital separation of zones is provided by the reliable, time-tested, high-performance Baker Retainer Production Packer.

Baker Snap-Set Dual Packers are available with hydraulic button-type hold-downs where high differential pressures are to be encountered from below.

Ask for Catalog Supplement No. 357, which completely describes these packers and their use in selective-multiple zone completions, in addition to several popular dual-zone hookups.

BAKER SNAP-SET DUAL PACKERS
Shown is the Model "J", Single-Grip, Product No. 756-J.


Baker Parallel Snap-Latch Seal Nipple Product No. 707 (Not a Part of Packer)
Baker Single-Grip Snap-Set Dual Packer Product No. 756-J or Baker Double-Grip Snap-Set Dual Packer Product No. 757-J
Side Door Completion or Sleeve Valve
Baker Locator Tubing Seal Assembly Product No. 442-E2
Baker Retainer Production Packer Product No. 415
Baker Production Tube Product No. 457

CATALOG SUPPLEMENT NO. 357 describes Baker Snap-Set Dual Packers in complete detail.

"Dog-eared" is a term sometimes applied to gravity and magnetics as exploration tools, but these "old guard" methods of exploration can teach many of us new tricks about getting certain prospects surveyed quickly, efficiently and economically.

A number of tails began wagging after explorationists stood up on their hind legs and took a new sniff at prospects via the gravity-magnetics route. If you are interested in cutting costs, while answering specific geologic questions, give us a whistle and we'll trot out our new Bulletin GM59-1, **"Gravity-Magnetics . . . what they *can* and *can't* do for the explorationist."**

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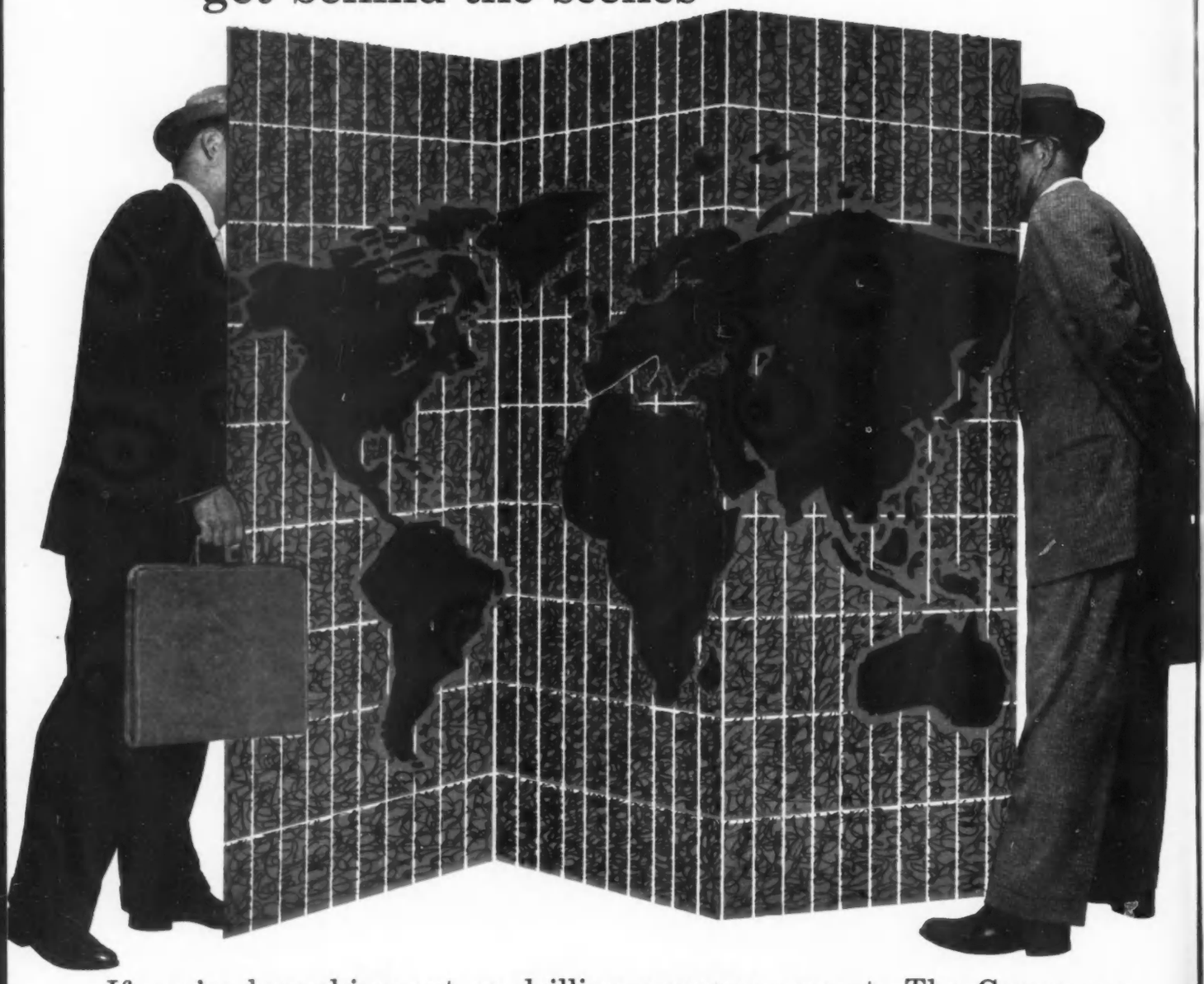
get behind the scenes



If you're branching out or drilling overseas come to The Commerce

There's so much you'll want to know, and there's no reason for finding it out the hard way. The Oil and Gas Loan Department and International Banking Department of The Commerce can guide you every step of the way. Whether you're setting up a sales office, establishing a plant, or are going to drill overseas, you'll get up-to-the-minute advice and help based on years of experience working with others who are overseas now. Working with The Commerce and its overseas correspondents, you'll get the specific, detailed kind of help that can mean profitable foreign operations.

THE NATIONAL BANK OF
COMMERCE
OF HOUSTON

GULF BUILDING • MAIN AT RUSK • HOUSTON, TEXAS, U.S.A.

MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

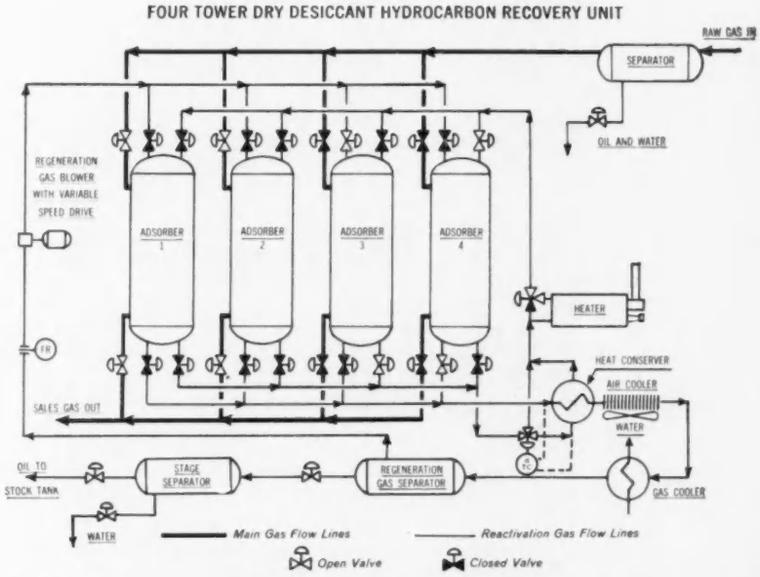
Why 4 — Tower DRY FRAC* is — ways better for 50 MMSCFD and up!

The BS&B Short-Cycle Hydrocarbon Recovery Unit known as the 4 Tower DRY FRAC offers four principal advantages over a 3 tower system of comparable capacity for the processing of moderate pressure lean gas streams of 50 MMSCFD and up. They are:

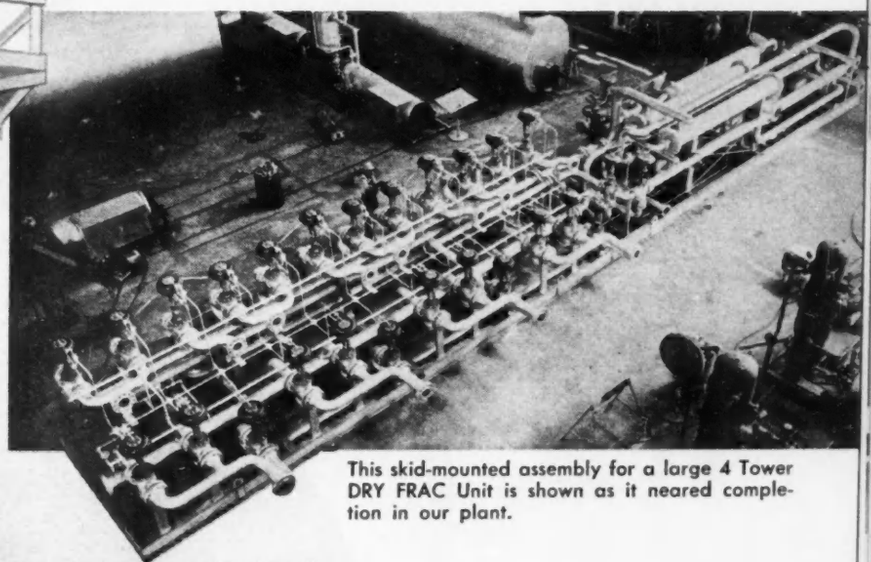
1. **Higher Recovery Efficiency**
2. **Lower Initial Cost**
3. **Lower Operating Cost**
4. **Less Variation in Outlet Gas Temperature**

Dependable, compact, safe and completely automatic in its operation, the 4 Tower DRY FRAC can be designed for either water or air cooling. Available with either open or closed cycle regeneration. Optional accessories also available.

FOUR TOWER DRY DESICCANT HYDROCARBON RECOVERY UNIT



Flow diagram of a typical 4 Tower DRY FRAC Unit With Closed Cycle Regeneration. Smaller diameter towers and smaller valves of standard sizes contribute to reduction in cost of this type unit.



This skid-mounted assembly for a large 4 Tower DRY FRAC Unit is shown as it neared completion in our plant.

These four towers, with the addition of piping and accessory equipment, will complete the unit.

*DRY FRAC is a trade name of Black, Sivalls & Bryson, Inc.

For more detailed information on the 4 Tower DRY FRAC, ask your BS&B Man, or write directly to . . .

OVER 60 YEARS BS&B ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

BLACK, SIVALLS & BRYSON, INC.

DEPT. 1-B12 P.O. BOX 1714, OKLAHOMA CITY

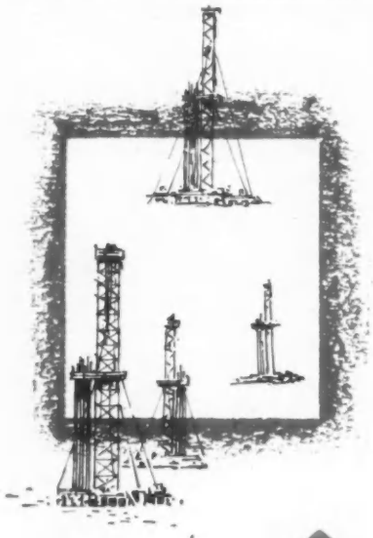
DMS®

for

STABLE DRILLING MUDS

IN LOW-SOLIDS MUDS

IN WEIGHTED MUD SYSTEMS



DMS is a water soluble nonionic surfactant for use in all drilling muds.

DMS muds are stable to high temperature, salt and anhydrite.

DMS muds have been used as drilling fluids with weights up to 22 ppg and with temperatures up to 450°F.

DMS reduces consumption of fluid loss additives and improves their efficiency in all systems, even saturated salt muds.

DMS muds minimize dispersion of drilled solids and reduce maintenance and watering back.

DMS, packed in distinctive red checked drums, is available in all drilling areas.

Consult your local Baroid or Magcobar Dealer for product know-how and Service.

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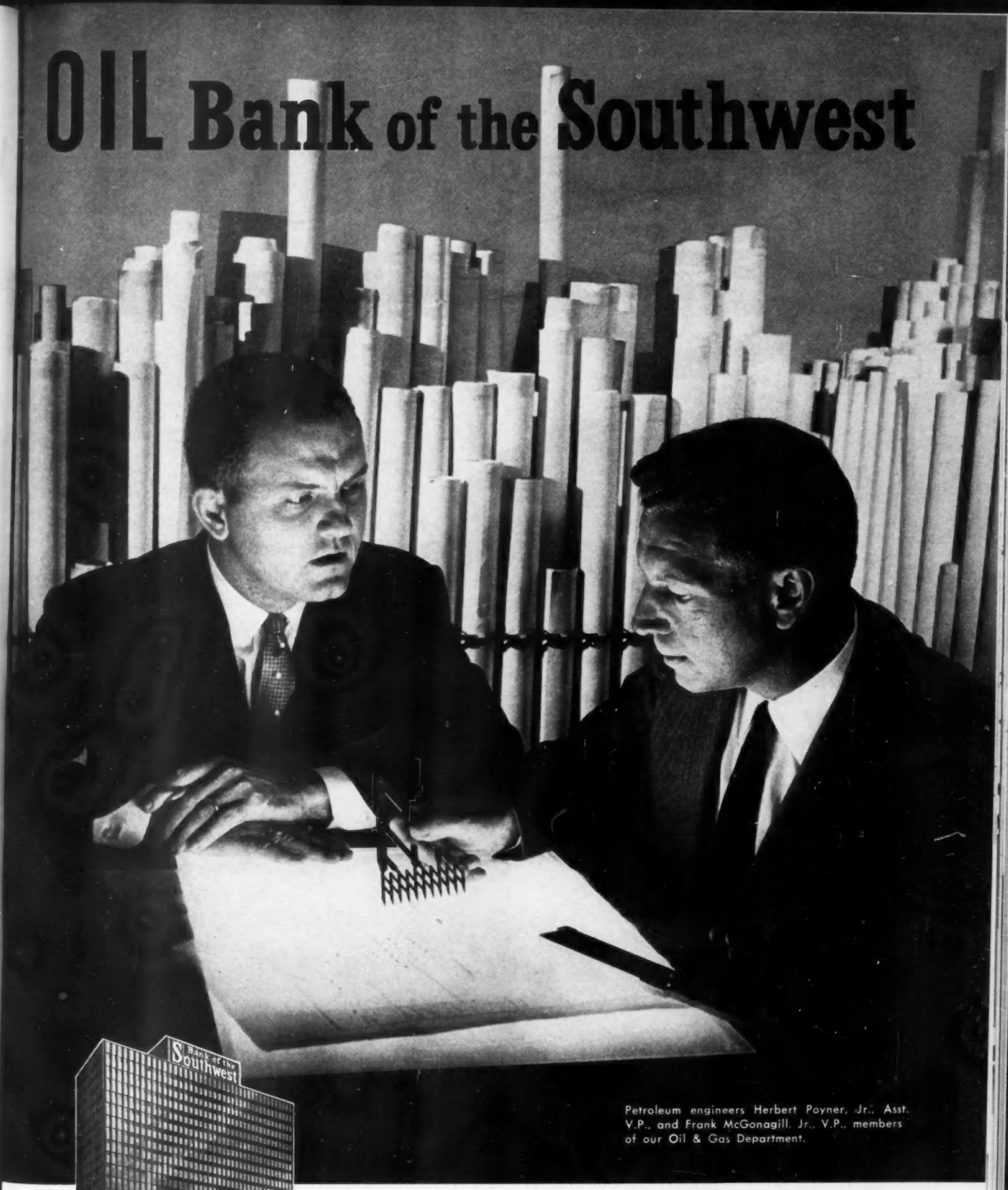

Petroleum engineers Herbert Poyner, Jr., Asst. V.P., and Frank McGonagill, Jr., V.P., members of our Oil & Gas Department.

BANK OF THE SOUTHWEST offers the ultimate in scope and quality of counsel to the petroleum industry. The seasoned members of our Oil & Gas Department were oil men before they were bankers. A large number of our directors and Advisory Committee also are oil men. That's why our bank is known as the Oil Bank of the Southwest. For information, write Harold Vance, vice president and manager, Oil & Gas Department.

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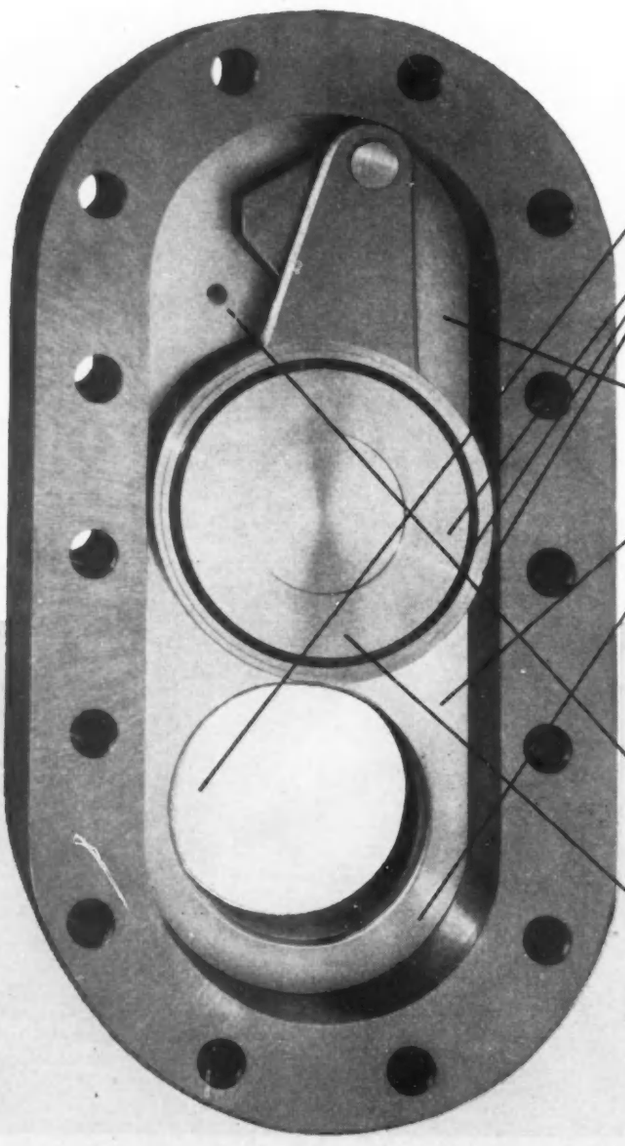
GROVE
Series
G-5

A new, with all the



Full Opening

Protected Seal-O-Ring Design—Unique Grove engineering places nitrile rubber O-rings and rugged metal seat rings on the gate, so that when in the open position, they are completely elevated away from foreign matter in the flow stream.

Continuous, Perfect Contact—Metal seat rings are firmly held in contact with polished and chrome plated body side plates to guarantee a continuous contact for scraping action through all gate positions. Squeegee action of the Seal-O-Rings maintains an immaculate surface on the side plates for perfect sealing.

No Lubrication—Ever

Bleeder Plug—Permits venting body cavity in closed position.

Springs Behind Seat Rings—Firmly hold both metal seat rings against polished body side plates.

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A Subsidiary of Walworth Corporation
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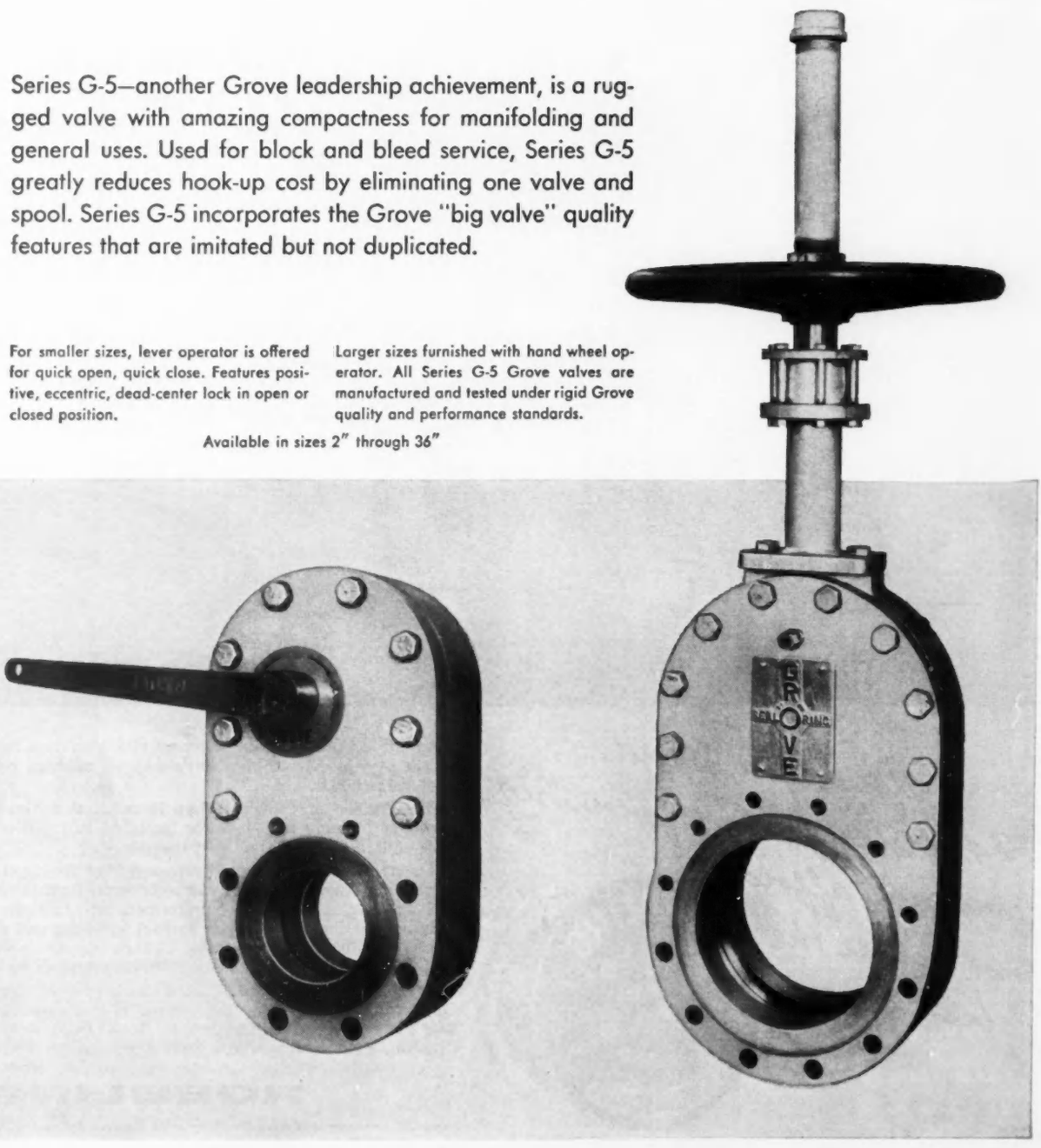
more compact valve proven GROVE features!

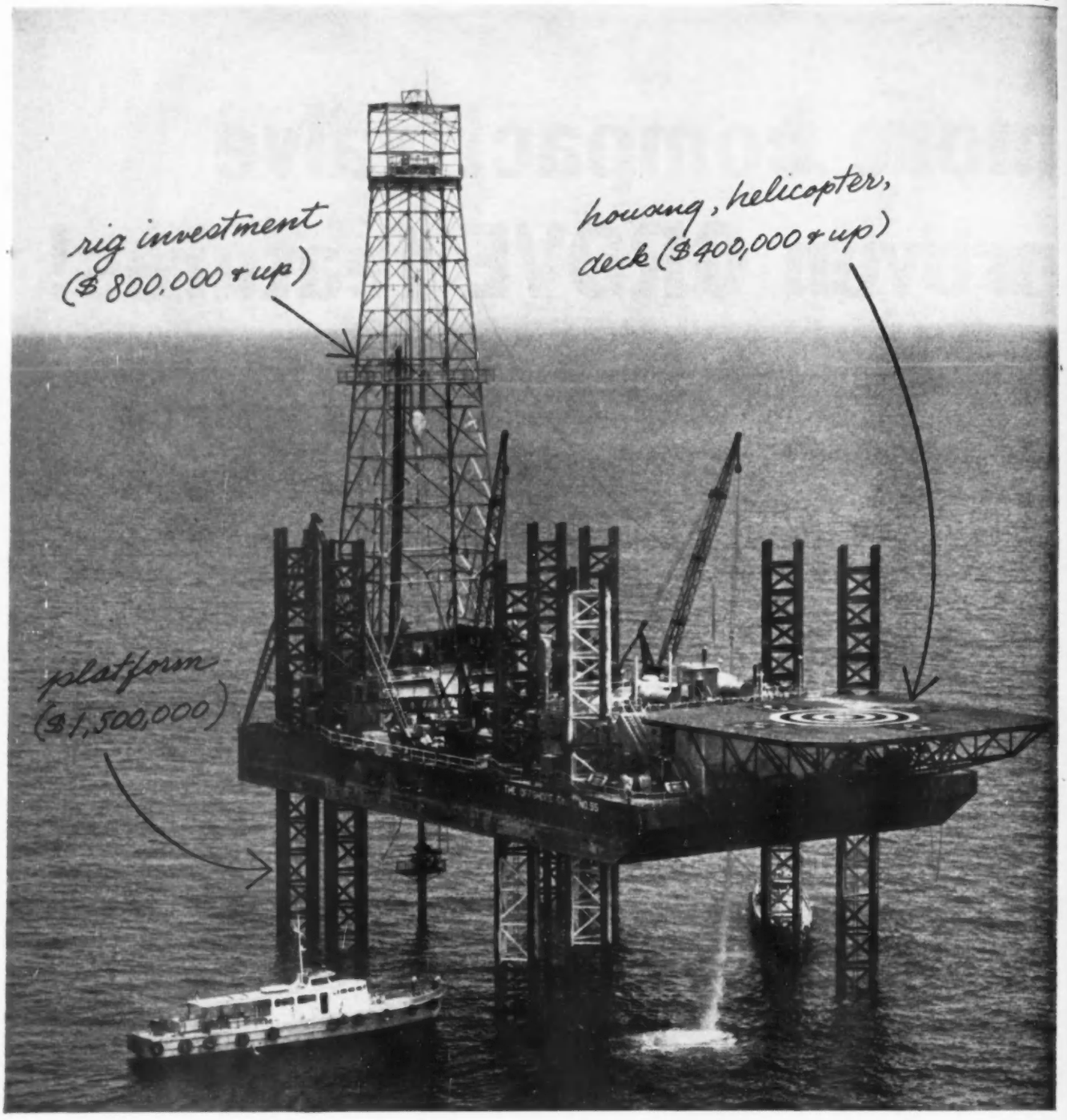
Series G-5—another Grove leadership achievement, is a rugged valve with amazing compactness for manifolding and general uses. Used for block and bleed service, Series G-5 greatly reduces hook-up cost by eliminating one valve and spool. Series G-5 incorporates the Grove "big valve" quality features that are imitated but not duplicated.

For smaller sizes, lever operator is offered for quick open, quick close. Features positive, eccentric, dead-center lock in open or closed position.

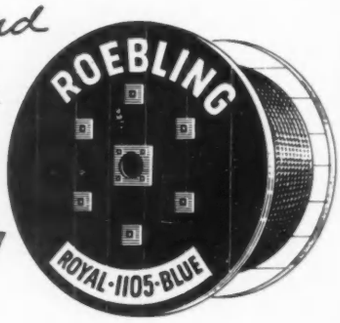
Larger sizes furnished with hand wheel operator. All Series G-5 Grove valves are manufactured and tested under rigid Grove quality and performance standards.

Available in sizes 2" through 36"





When you spend $4,000,000 for an offshore rig you can't afford not to use the best rope



You wouldn't use Bargain Basement bits. You'd get the best. You'd get the best of everything; that's why an offshore rig can run as much as $4,000,000.

To settle for anything less than Royal Blue at this stage would, indeed, be "pound foolish." For Roebling Royal Blue Wire Rope represents in *its* field, the finest there is.

It is made from the toughest rope wire ever produced—Type 1105—extra high-strength improved plow steel. Royal Blue has all the hard-working advantages of preformed construction; outstanding resistance to abrasion, fatigue, impact, crushing and shock; exceptional flexibility and ruggedness. Collectively, these values add up to 15% more strength than in any other rope you have ever used.

Anything less than Royal Blue can cost you *more*. Your distributor has Royal Blue right now. Get it now and save and save and save. For information on Royal Blue, write Wire Rope Division, John A. Roebling's Sons Corporation, Trenton 2, N. J.

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FOR HIGHER PUMP EFFICIENCY IN GASSY OR FOAMY WELLS

specify

oilmaster

RATIO-COMPOUND PUMPS

...designed to eliminate gas lock and improve pump efficiency in wells where a high percentage of gas must be produced along with the well fluid.

When a conventional pump becomes loaded with gas, a gas lock frequently results, and high static pressure on the traveling valve makes this gas lock difficult to break. In the Ratio-Compound Pump, this high static pressure is carried by the top traveling valve, and during the downstroke the second stage pulls a suction on top while the first stage applies pressure below the intermediate traveling valve. Therefore, it opens promptly at the beginning of the downstroke even if the pump is filled with foam or gas. The improved valve action eliminates gas lock and improves pump efficiency.

A bonus feature of the novel two-stage design is the absence of gas or fluid pound in the low efficiency range. Static pressure acts on the hollow polished rod when the top traveling valve is closed and actually pulls a tension in the rod string during the downstroke, resulting in improved plunger travel, decreased load range on the rods, reduced torque on the unit gear box, and lowered horsepower requirements on the prime mover.

If you have the problem of pumping foamy or gassy oil, call your Oilmaster representative and ask him about the Ratio-Compound, or write Fluid Packed Pump Co., Box 64, Los Nietos, California for literature.

oilmaster PUMPS — FOREMOST IN THE INDUSTRY

FLUID PACKED PUMP CO.

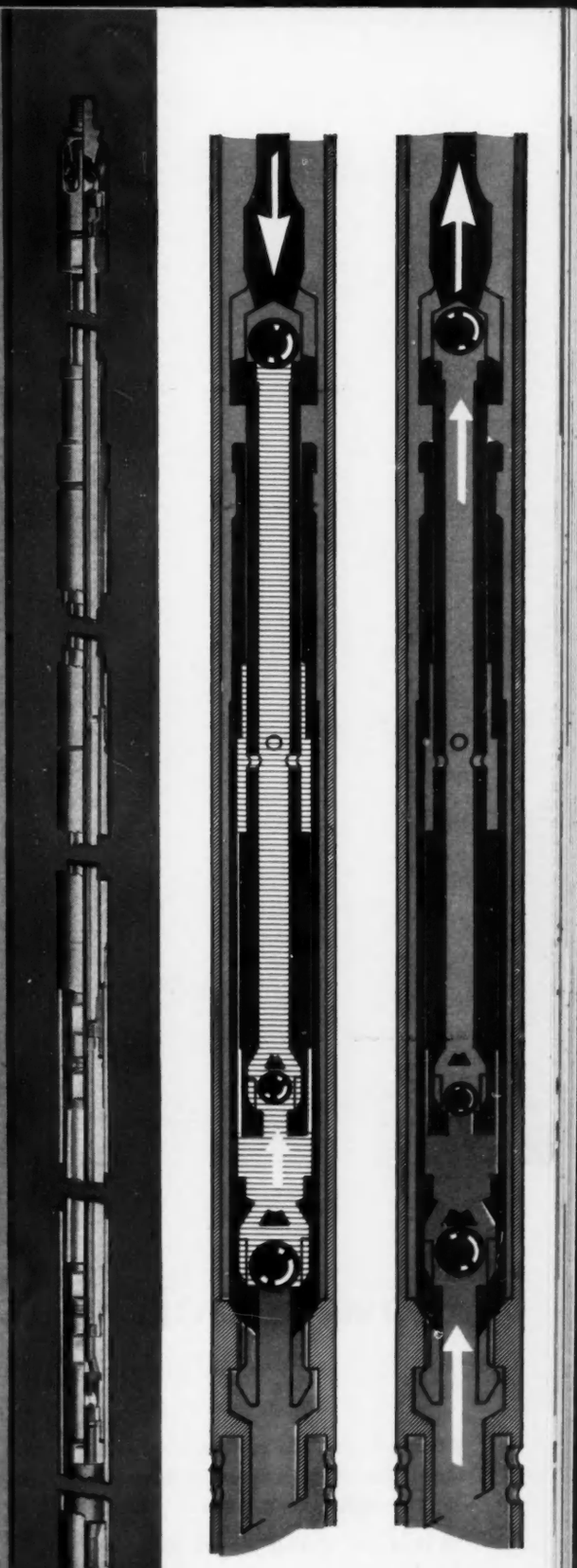
Division of the National Supply Company

Main Office and Plant, Los Nietos, California.

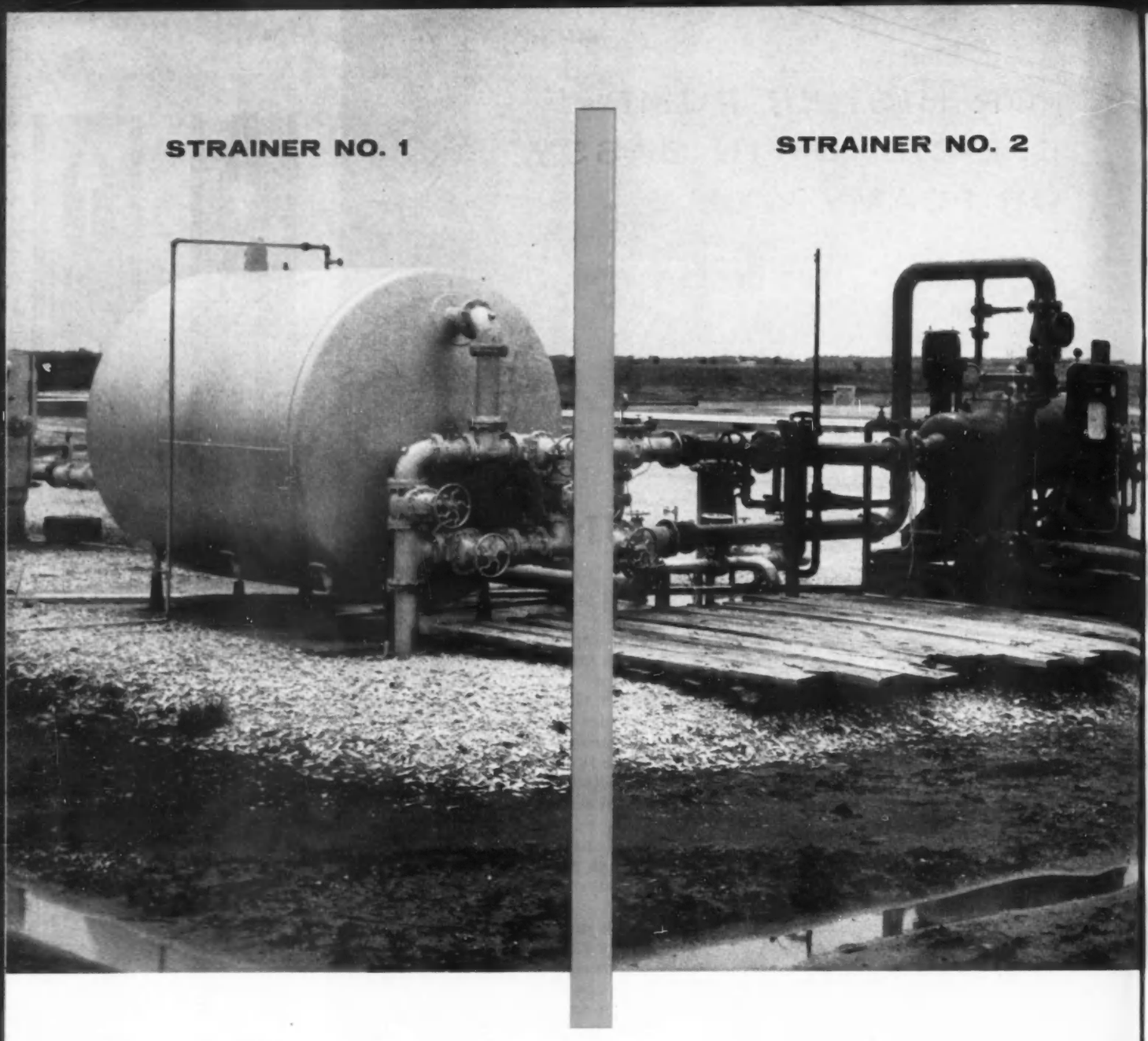
Distributed by the National Supply Co., Pittsburgh, Pa.

Export: The National Supply Co., Export Division, 600 Fifth Avenue, New York

Co-Distributors: Union Supply Company, Beacon Supply Co., Industrial Supply Co.



On the upstroke, fluid and gas enter the pump through the standing valve into the full area of the barrel underneath the plunger. This is the first stage chamber. At the beginning of the downstroke, the top traveling valve closes, the gas is compressed and the fluid is displaced into the second stage chamber which is the annular area between the hollow polished rod and the barrel above the plunger. On the subsequent upstroke the top traveling valve opens and the annular chamber discharges the fluid and compressed gas into the tubing.



How much water can a strainer strain?

The answer is important in water-flooding

Strainer No. 1 is a conventional rapid sand filter. It is designed to filter *180* gals. of water per minute.

Strainer No. 2 is a Model 30-H. T-C Jet Strainer. It is designed to filter *450* gals. of water per minute.

The cost of the two strainers is approximately the same, considering the cost of auxiliary equipment required by the sand filter that is not needed with the Jet Strainer.

To clean the sand filter requires backwashing with filtered water. This takes time . . . costs money. The Jet Strainer can be cleaned in less than 5 minutes, requires no backwashing.

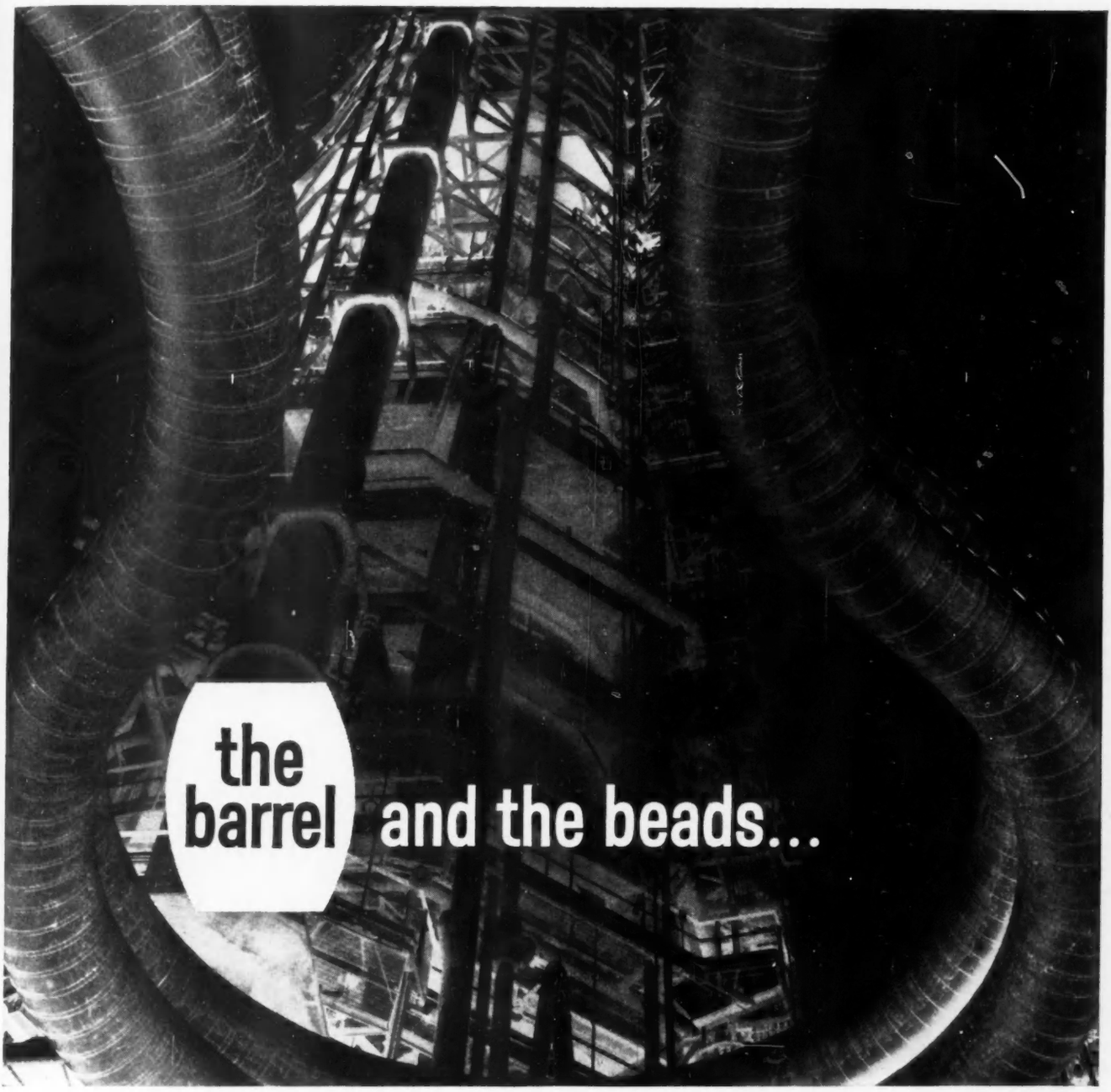
But the real pay-off is the difference in the filtering performance of the two types of strainers. The sand filter removes solids of a questionable minimum particle size . . . no algae or bacteria. The Jet Strainer can remove all solids down to 31-micron particle size with a bare screen. With a coating of filteraid on the screen the Jet Strainer removes all solids down to sub-micron particle size, including algae and bacteria!

Jet Strainer design lends itself ideally to full automatic operation, using any desired make of electronic controls.

Planning a water-flood? We will gladly send you complete details on T-C Jet Strainers.

T-C JET
Self Cleaning
STRAINERS

THORNHILL CRAVER CO.
P. O. Box 1184 Houston, Texas



How to get more yield from a barrel of crude for less cost—the new bead catalyst that makes it possible—what it means to the petroleum industry

Petroleum refiners around the world have always had one common economic objective—to get more yield from every barrel of crude oil at lower cost.

Socony Mobil's contributions toward this goal have been outstanding. From the development of the first Thermofor Catalytic Cracking unit and its successor, the Airlift TCC, to the introduction of Durabead, the most efficient, cost-cutting bead catalyst today, Mobil Catalyst Research has led the way in pushing yield levels ever higher, yield costs ever lower.

Now Mobil takes the lead again with Heavy Durabead, a new bead catalyst with all the features of Durabead, plus important new advantages. Heavy Durabead can cut TCC unit construction costs as much as 20%. Used in present TCC units, it can increase reactor and regenerator capacities up to 50%, compared to chrome bead catalyst.

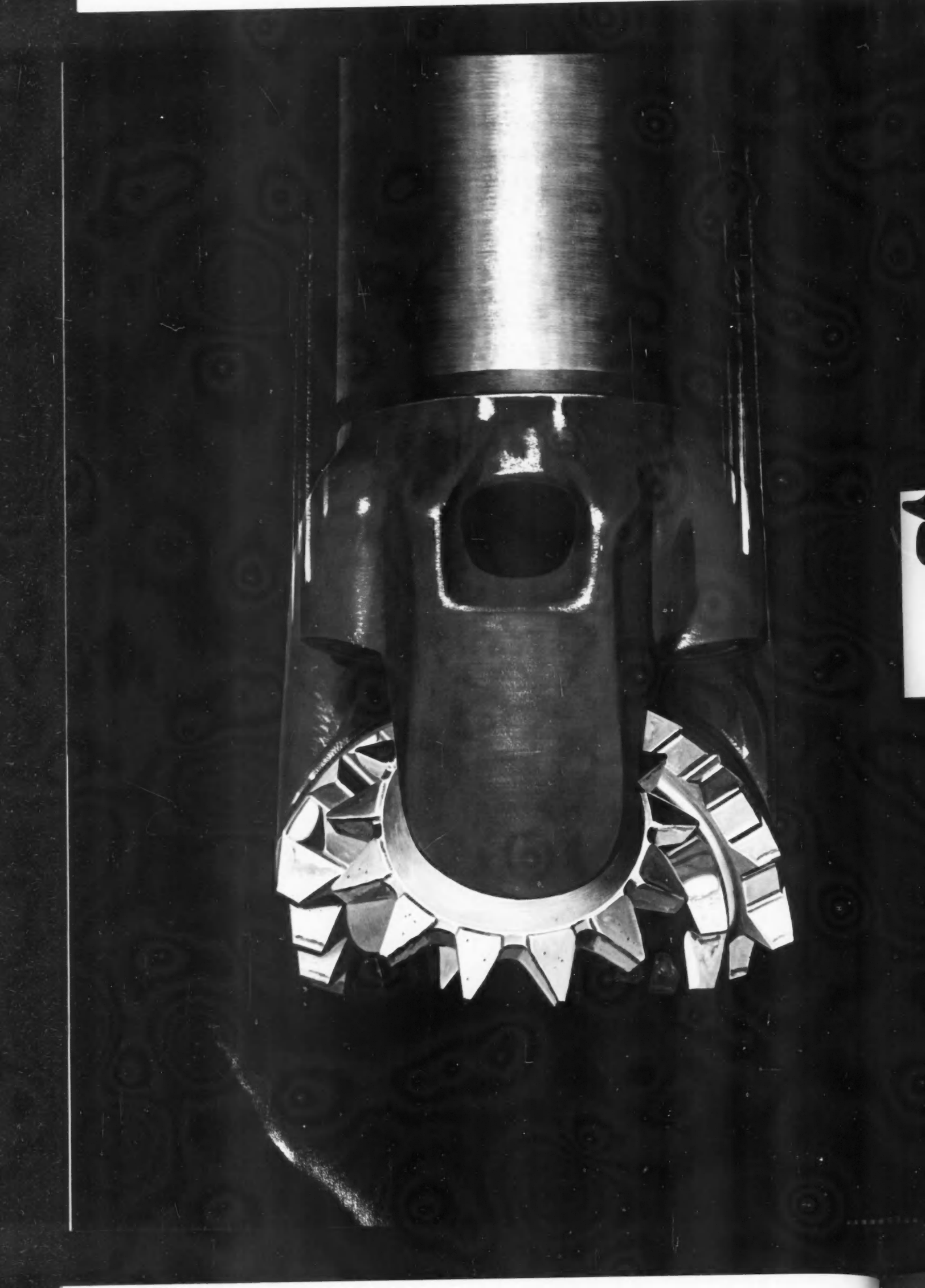
* * *

These are the results of Mobil Catalyst leadership—*greater yields of salable products from every crude oil barrel, increased profits for TCC licensees and operators of other moving bed units in the petroleum industry.*

Socony Mobil Oil Company

Leader in catalyst research

Mobil



ALMOST EVERYBODY IS USING REED BITS

and here's why . . .

In field after field, the new Reed Y bits are performing so well that the demand is exceeding our present plant capacity. To remedy this situation, we are expanding our research and production facilities and will soon be in much better position to supply your needs.

We now have available all the most popular sizes and types and are adding new sizes and types to our inventory as fast as possible. However, each new size and/or type requires many hundreds of hours of research, engineering, and testing. When we release a bit to the field, you can rest assured that it will dig with the best of them.

The Reed man in your field has some interesting facts to show you, facts that will help you cut your drilling costs. Give him a call today. You'll be glad you did.

REED ROLLER BIT COMPANY *Houston 1, Texas* EXPORT OFFICE: 1011 INTERNATIONAL BLDG., NEW YORK 20, N.Y.
GULF COAST, MID-CONTINENT, ROCKY MOUNTAIN AND CANADIAN DISTRIBUTOR FOR MARTIN-DECKER PRODUCTS

REED

REED'S ROLLIN'

For extra high strength wire rope...

use CF&I-Wickwire *Double Gray*

The CF&I Image reflects CF&I's experience as a producer of many steel products and CF&I's versatility in developing new products to meet exacting requirements . . . like Wickwire Double Gray*.

The special steel used in Double Gray provides extra resistance to the deforming effects of peening and crushing which occur on the drums and sheaves of heavy equipment. Double Gray also gives extra resistance to abrasion.

Because of these superior qualities, Double Gray rope quickly repays its slightly higher initial cost in safer, more economical operations. Use it wherever extra high strength wire rope is required.

For a free copy of our Double Gray booklet, write to: Advertising Department, The Colorado Fuel and Iron Corporation, 575 Madison Avenue, New York 22, N. Y.

**Wickwire Double Gray Wire Rope is made of extra-improved plow steel. Fortified by an independent wire rope core of the same extra high strength steel, Double Gray rope has a 15% higher breaking strength than the catalog breaking strength of an improved plow steel rope with IWRC.*

6632

WICKWIRE ROPE

THE COLORADO FUEL AND IRON CORPORATION

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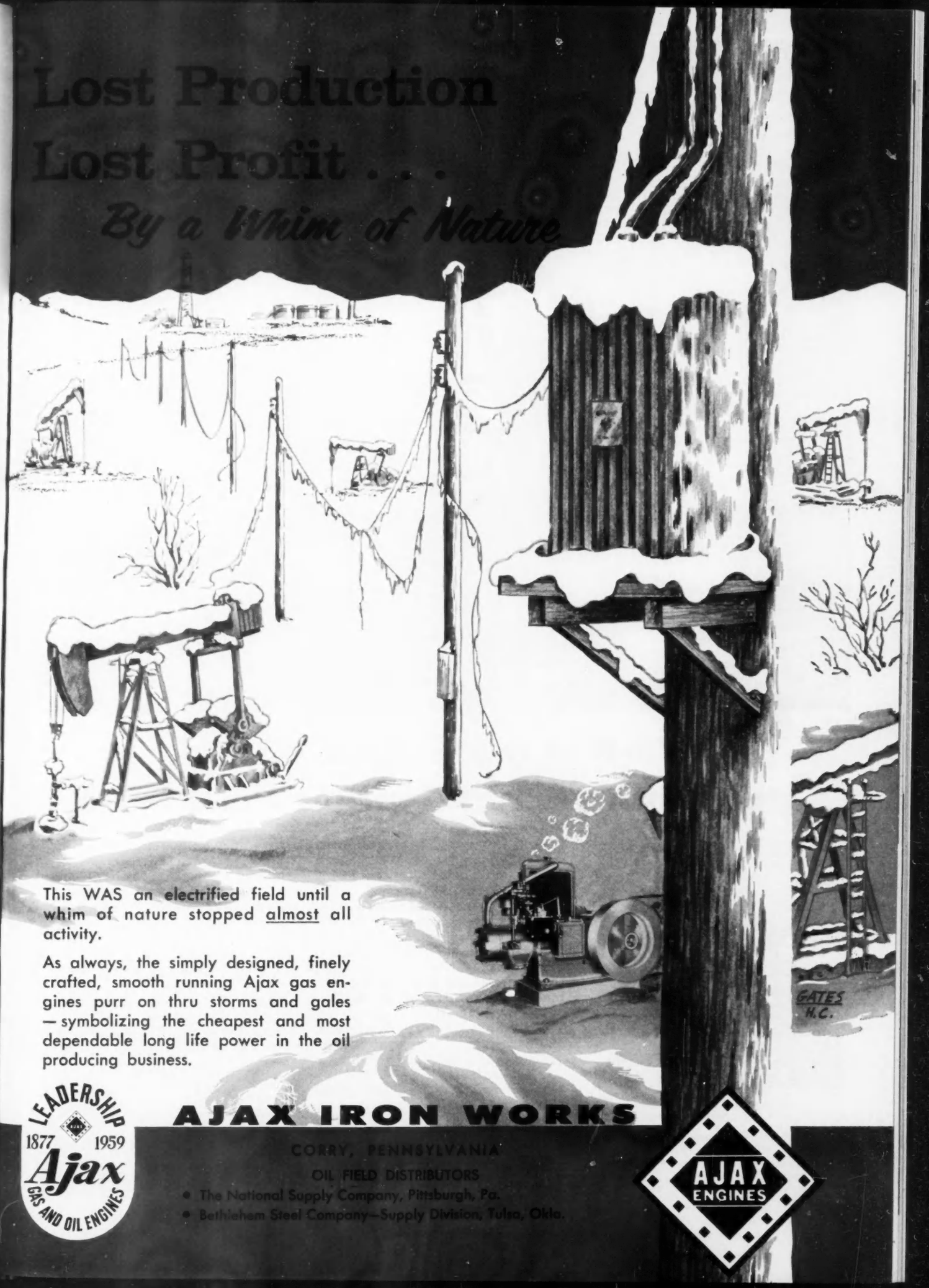
CF&I STEEL

Lost Production
Lost Profit . . .
By a Whim of Nature



This WAS an electrified field until a whim of nature stopped <u>almost</u> all activity.

As always, the simply designed, finely crafted, smooth running Ajax gas engines purr on thru storms and gales — symbolizing the cheapest and most dependable long life power in the oil producing business.

LEADERSHIP
1877 1959
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AJAX IRON WORKS

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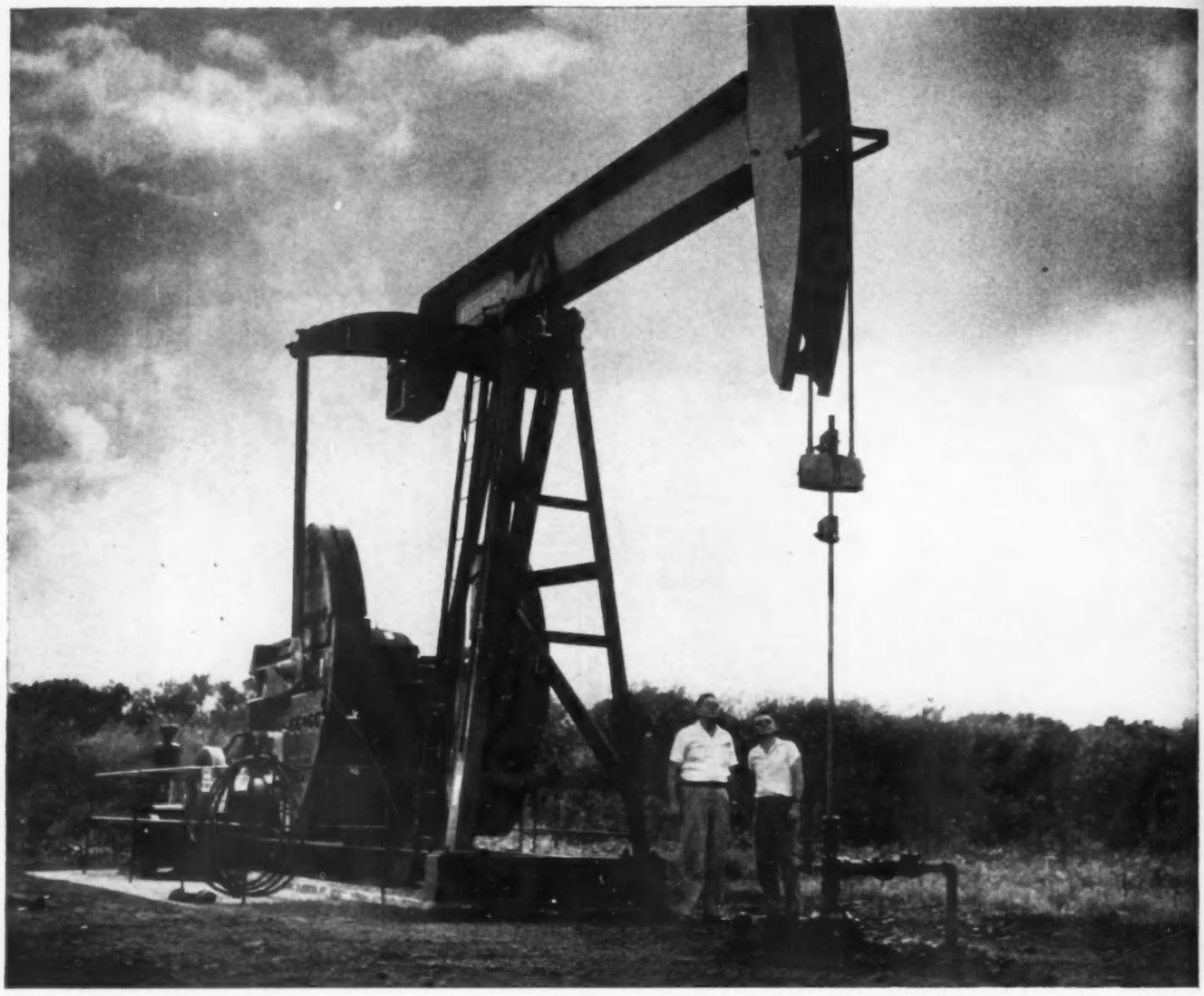
AJAX ENGINES



8175-ft string of Type 43 rods starts fifth year at Spargur Heirs No. 1

NO BENT OR KINKED RODS WITH BETHLEHEM PACKAGE

Bethlehem Sucker Rods come bundled in a unit package of 80 or 100 rods. Grooved steel spacers cradle rods, protect them from damage during shipment and handling. Package can be lifted easily, thus saving handling time.

Operated by Sun Oil Company, the Spargur Heirs No. 1 Well pumps from 8185 ft, using a tapered string of Type 43 rods: 6050 ft of ¾ in. and 2125 ft of ⅞ in. In steady service for over four years, these rods are still going strong.

Located in the Short Junction Field, southwest of Oklahoma City, this well pumps from the Hunton lime formation. It produces 10 bpd of 34-gravity oil, and 5 bpd of water. The pumping unit, a Bethlehem 320D-30S-120, operates at 5 spm, using a 120-in. stroke.

The Bethlehem Type 43 rod is a high-strength rod, made of nickel-chromium-molybdenum steel. It is normalized and tempered, and is recommended for extra-heavy loads in wells which are effectively inhibited against corrosion.

In addition to the Type 43 rod, Bethlehem produces three grades of carbon and alloy rods to enable operators to meet a wide range of pumping requirements.

If you have any question about which type of rod would be most economical for any given well, talk it over with your Bethlehem sucker rod distributor. Or drop a line to the nearest Bethlehem sales office.

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BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation

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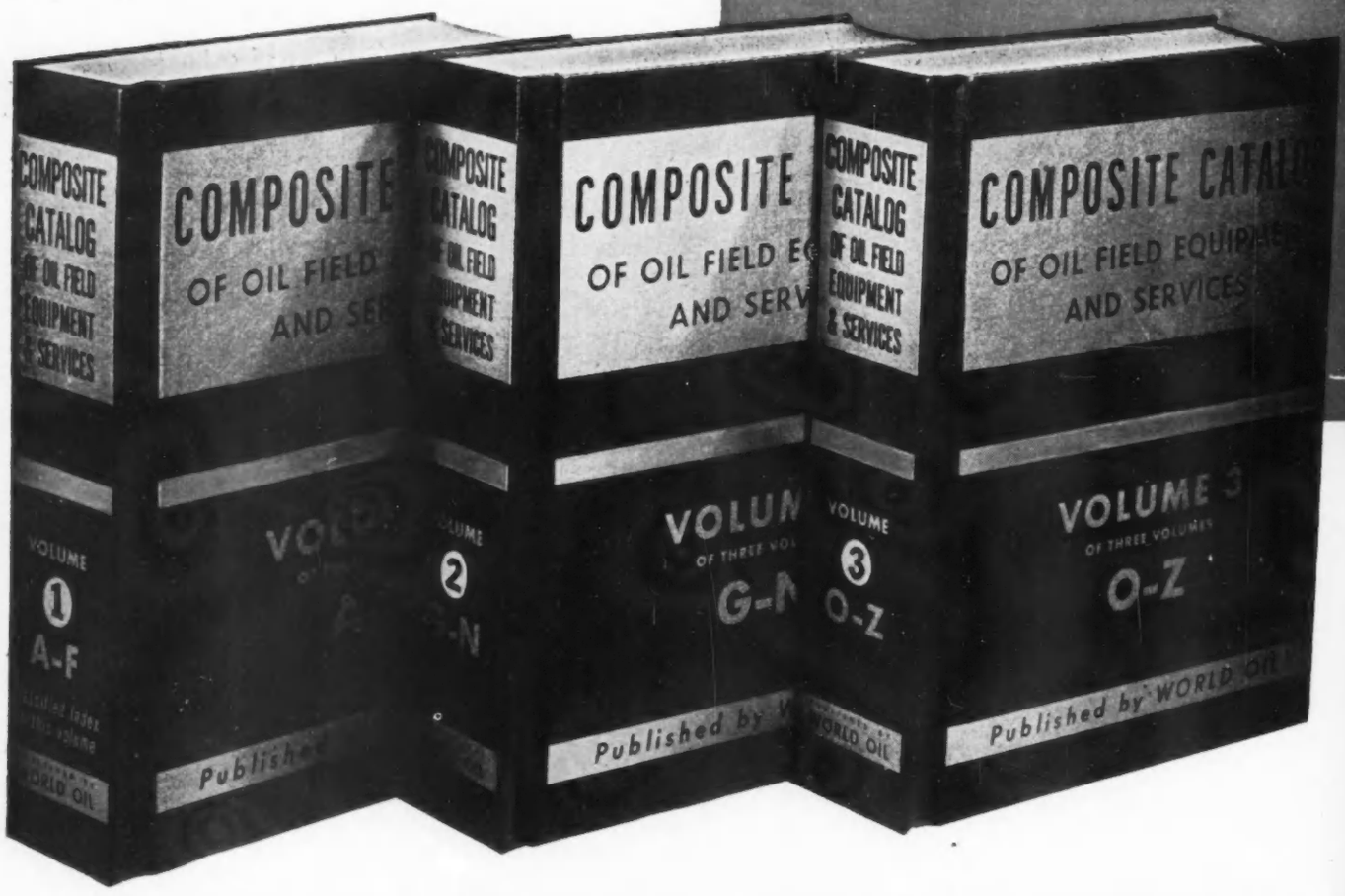

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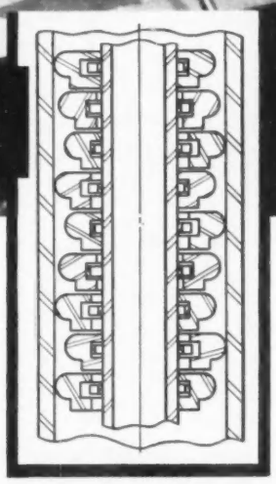
The Wobble Washers ride the tubing wall, continuously wiping fluid into the 11" seal section of the plunger.



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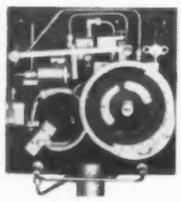

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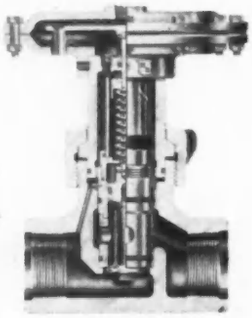

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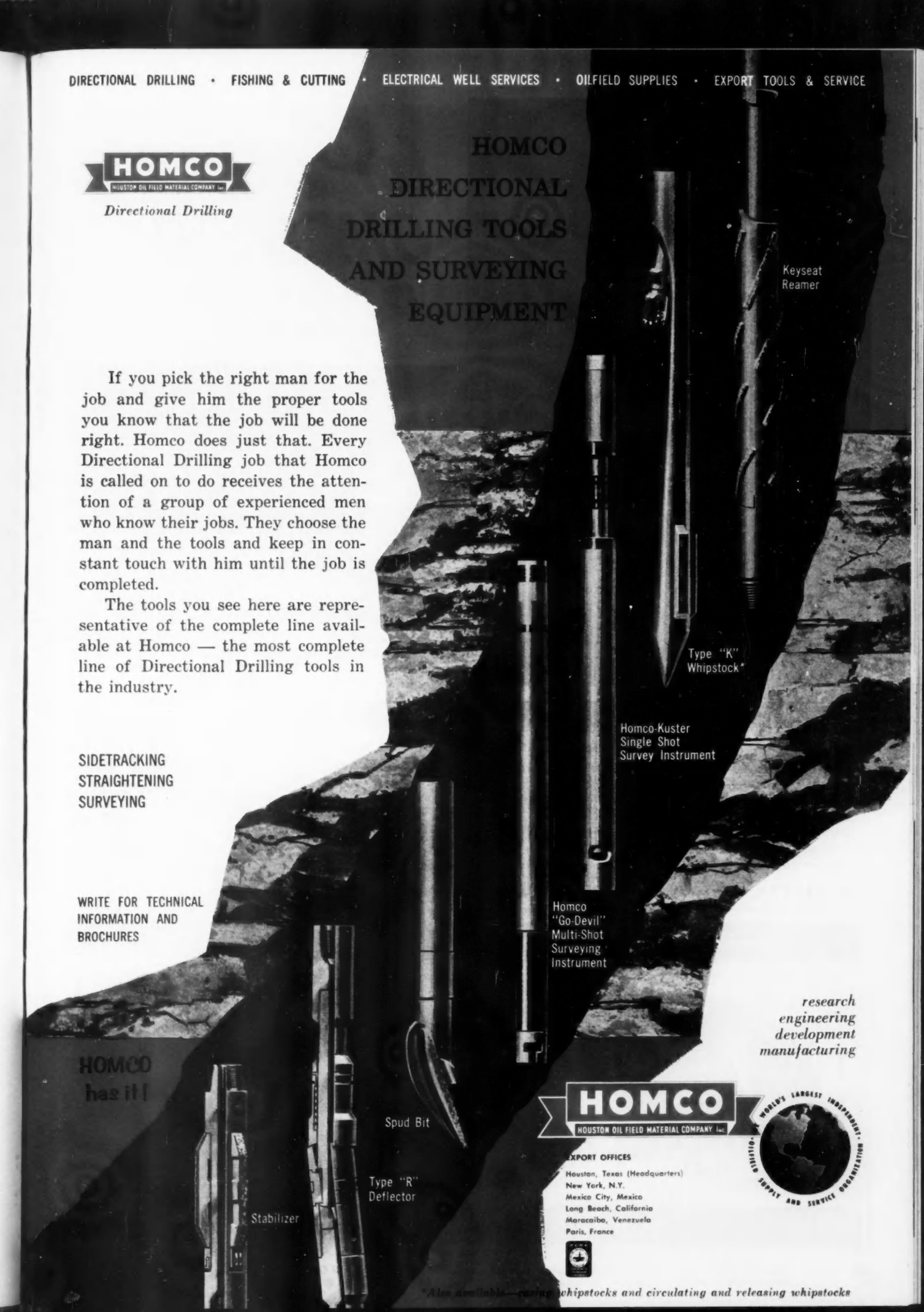

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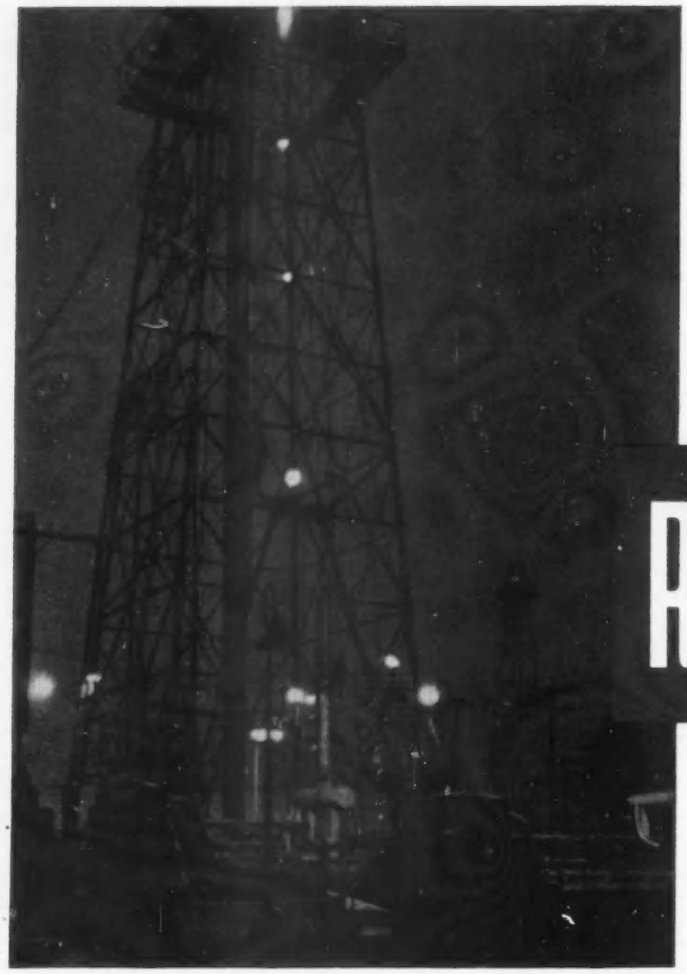

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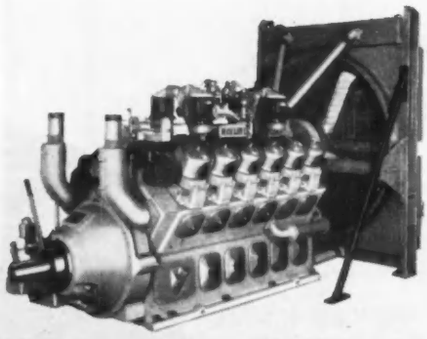

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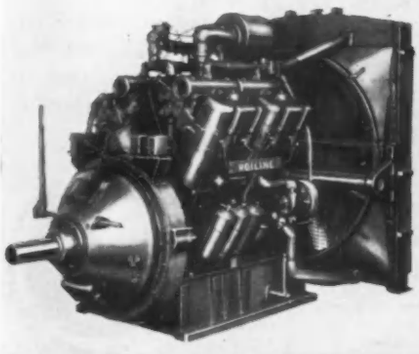
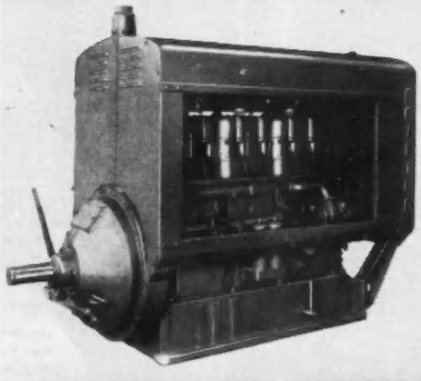
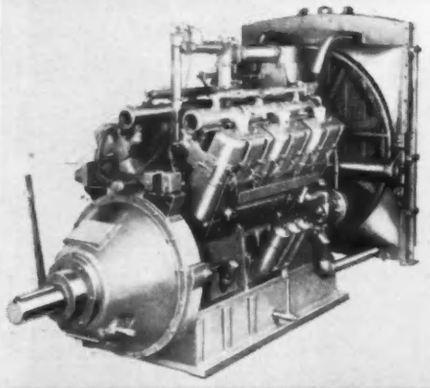


H-2000—8-cyl., 300 hp.



F-1500—6-cyl., 230 hp.



L-3000—12-cyl., 460 hp.

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"Much of the credit for this can be given the equipment and service industries whose continual research and development programs have offered solutions to many of the complex drilling and production problems.

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Gardner-Denver mud pumps are designed to keep your mud circulating . . . to handle high drilling pressures continuously without excessive maintenance. They are built with reserve strength to withstand the shock and high plunger loads of deep well drilling.

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CALL THE GARDNER-DENVER MAN

Your Gardner-Denver oil field specialist is trained to assist in solving your fluid circulation problems . . . to help keep your mud pump in tiptop shape. At Gardner-Denver *there's no substitute for men*—our 100-year philosophy of growth.

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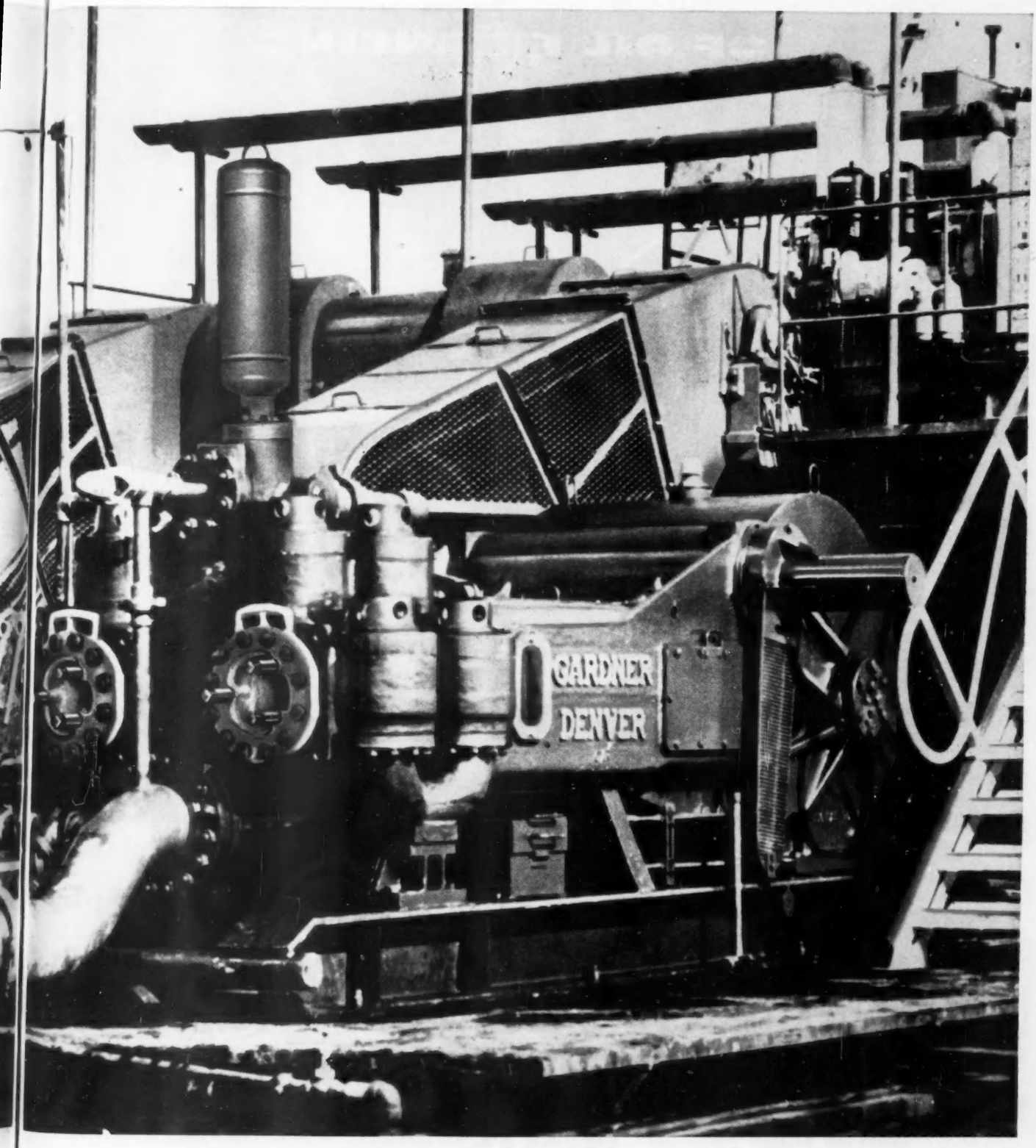
GARDNER-DENVER MUD PUMPS



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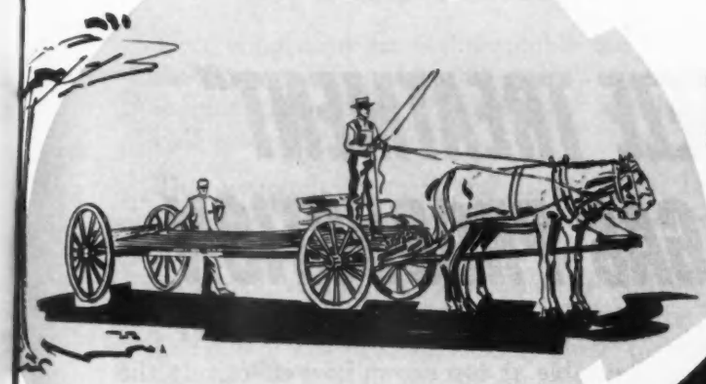
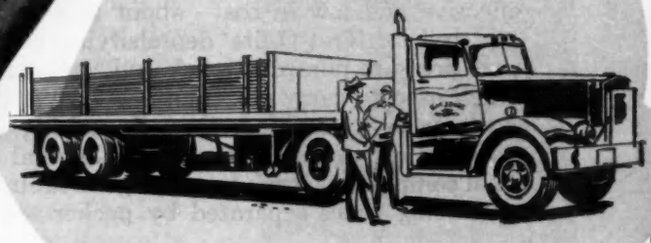


The first method of transporting Jones all-metal sucker rods left something to be desired. Not much support for those rods between the wagon axles...

FIRST TODAY...



Now, Jones Sucker Rods receive the greatest care in handling and shipping...rail or truck...so that they arrive with factory perfection. Another service you can expect from **Sucker Rod Specialists!**

...because we're Sucker Rod Specialists!

There are four JONES JOB-ENGINEERED SUCKER RODS... a type for every pumping need!

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WELL	DEPTH	MAXIMUM INJECTION PRESSURE	PRODUCTION BEFORE SQUEEZE		PRODUCTION AFTER SQUEEZE		GAIN BBLS. /DAY
			BBLS. OIL/DAY	MCF GAS/DAY	BBLS. OIL/DAY	MCF GAS/DAY	
1	9642	4800	34	153	61	593	27
2	8381	3000	30	5	52	83	22
3	9640	3600	35	224	87	323	52
4	9625	4500	40	672	50	497	10
5	8484	3700	27	339	51	700	24
6	9652	3000	53	35	83	353	30
7	8397	5200	30	32	125	238	95
8	8408	3800	15	12	129	94	114
9	9310	3600	0	0	123	760	123
		TOTAL	264	1472	761	3641	497

another
TRETOLITE SERVICE
report

9-well treatment program pays for self in 2 days!

TRETOLITE "SQUEEZE TREATMENT" DOUBLES OIL AND GAS PRODUCTION

The treatment of these nine wells was simple, effective and low in cost—about $300 to $350 per well for Tret-O-lite* demulsifying chemical plus pressure pumping truck and vacuum tank truck used to carry out treatment. Most of the wells were completed through tubing, with packers set above perforations. Several were dual completions, with two strings of tubing and producing zones separated by packer settings.

HOW TRET-O-LITE CHEMICAL DEMULSIFIER WAS USED

Sixty barrels of crude were mixed with 30 gallons of Tret-O-lite demulsifier. This mixture was pumped into tubing of each well, followed by enough crude to allow about 300 feet of oil-chemical mixture to stand in tubing. Each well was then shut in for 18 to 24 hours.

RESULTS OF TREATMENT

The table at top shows how effectively the Tret-O-lite demulsifier squeeze improved production in the 9 wells.

One day's gain in production in these 9 wells was such as to pay for cost of total squeeze job in about 2 days!

*Tret-O-lite is a registered trademark of Petrolite Corporation.

Tretolite products are helping to achieve similar savings for thousands of other producers. To find out how you can profit, *ask the Man in the Red Car,* Or write to . . .

TF59-2

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Metal to Metal Wear...

is the real villain in sucker rod pump troubles. It accounts for most of your repair and pump pulling expense.

The Martin Idea...

for getting away from this trouble has always been to make use of the best available materials — *Natural Rubber* for the key material in plunger rings; *Synthetic Rubber* for the key material in resilient ball guides for cages.

The accurately grooved and drilled metal body of **The Martin Plunger** does not touch the barrel. Only the resilient rubber and duck rings contact the barrel. This material — with its great natural resistance to abrasion as well as its slipperyness-when-wet — has a much slower wearing action on the barrel. Most often your barrel will not need replacing. These rings have an amazing ability to take the kind of abuse that goes with oil well pumping, and this means longer runs. Plunger cost is reduced because replacing the rings costs only about one fourth as much as a new plunger, and this saving is, of course, added to the barrel saving and longer runs.

Patent No. 2,591,174

The Martin Rubber Guide Cage protects the ball from all metal contact except when it rests upon its seat. The ball is protected to such an extent that ball and seat life is usually doubled. The synthetic ball guide and stop cannot beat out because of its resilience. Its life is therefore much greater than any metal and you get this longer cage life in addition to better ball and seat life. The two guides are easily replaced when the occasion does arise.

No real capital outlay is required to get these benefits because the cost of Martin Plungers and Martin Cages is very much the same as you are now spending for replacements — sometimes less.

All regular or stroke-thru ROD PUMPS and TUBING PUMPS can be equipped with Martin Plungers. Martin Rubber Guide Cages are made in all sizes and styles. Write for our new 1960 catalog.

JOHN N. MARTIN

Manufacturer

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How tough can a casing joint get?

USS National Buttress-Thread joint takes brutal pounding but remains intact!

Six times a 4000-pound steam hammer, under terrific velocity, slammed down onto the USS National Deep-Well Casing, driving it into the Super Deep-Well Coupling. Inside the coupling, the threads played leapfrog—the two sections of casing met in the middle of the coupling, and climbed all over each other. With each smashing blow, the coupling "bellied" out until it began to look like a buckled barrel. But it remained intact.

How tough can deep-well drilling get?

This test is a simulated drop test, designed to approximate, as closely as possible, severe field conditions. Although the test is more severe than any shock load a string of casing might encounter in the hole, it proves conclusively that the Buttress-threaded and coupled joint is more than ready to withstand tough deep-well stresses.

In addition to this drop test, many hydrostatic and galling tests have been made at the mill on the Buttress-Thread joint, with highly successful results. The high tensile strength of the patented Buttress-Thread joint is due largely to the combined effect of the completely engaged runout threads and the three-degree flank angle of the thread which supports the weight of the casing in the well. The joint is virtually as strong as the body of the pipe.

For further information on National Seamless Threaded and Coupled Casing, or other National Seamless Oil Country Tubular Products—Deoxidized Bessemer Steel Casing and Tubing, Warm-Worked Casing, Threaded and Coupled Drill Pipe, *Deep-Well* Casing, *Super Deep-Well* Casing, and Hi-Pres-Sure External-Upset Tubing—write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa. Export Distributors: United States Steel Export Company, New York.

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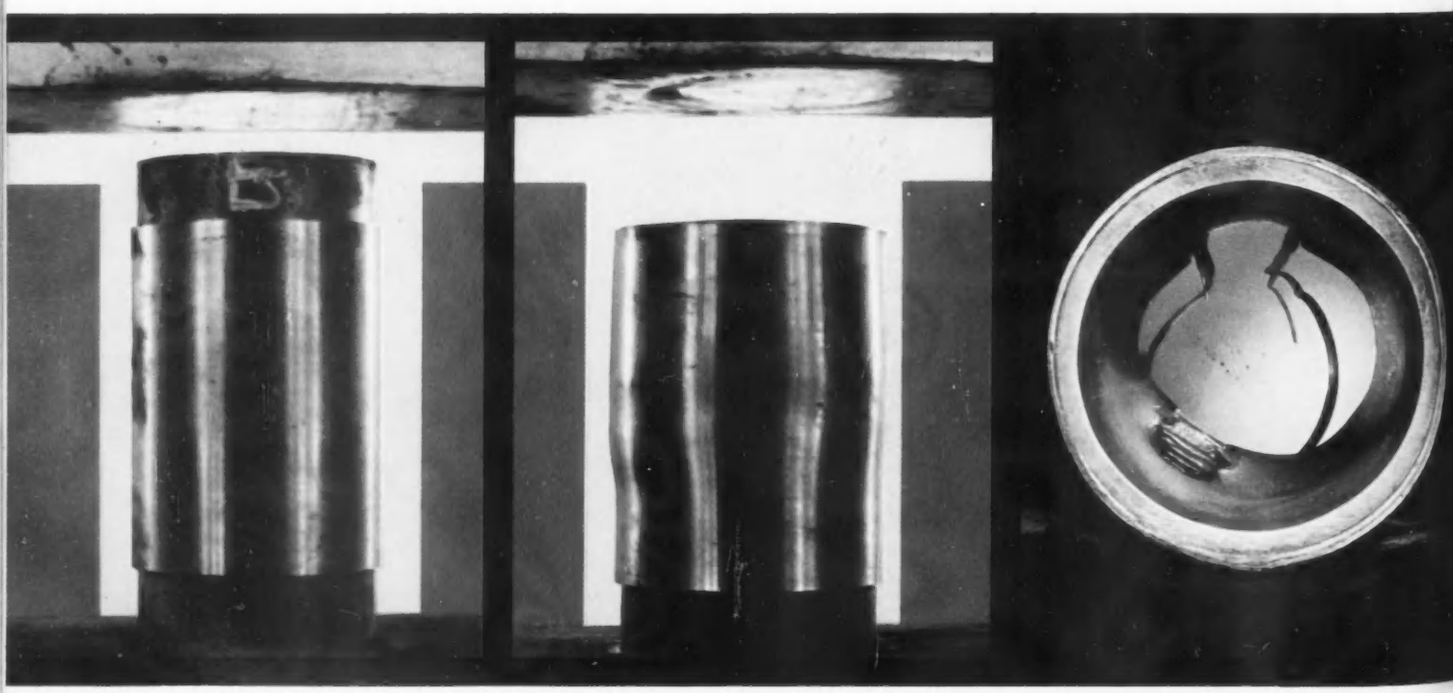
USS National Tube Division of United States Steel

The world's largest and most experienced manufacturer of tubular products



1. **Under the power hammer.** The red cards in the rear provide straightedge for measuring distortion.

2. **After six blows with the power hammer.** The top section of casing has been driven down completely out of sight, barreling the coupling.

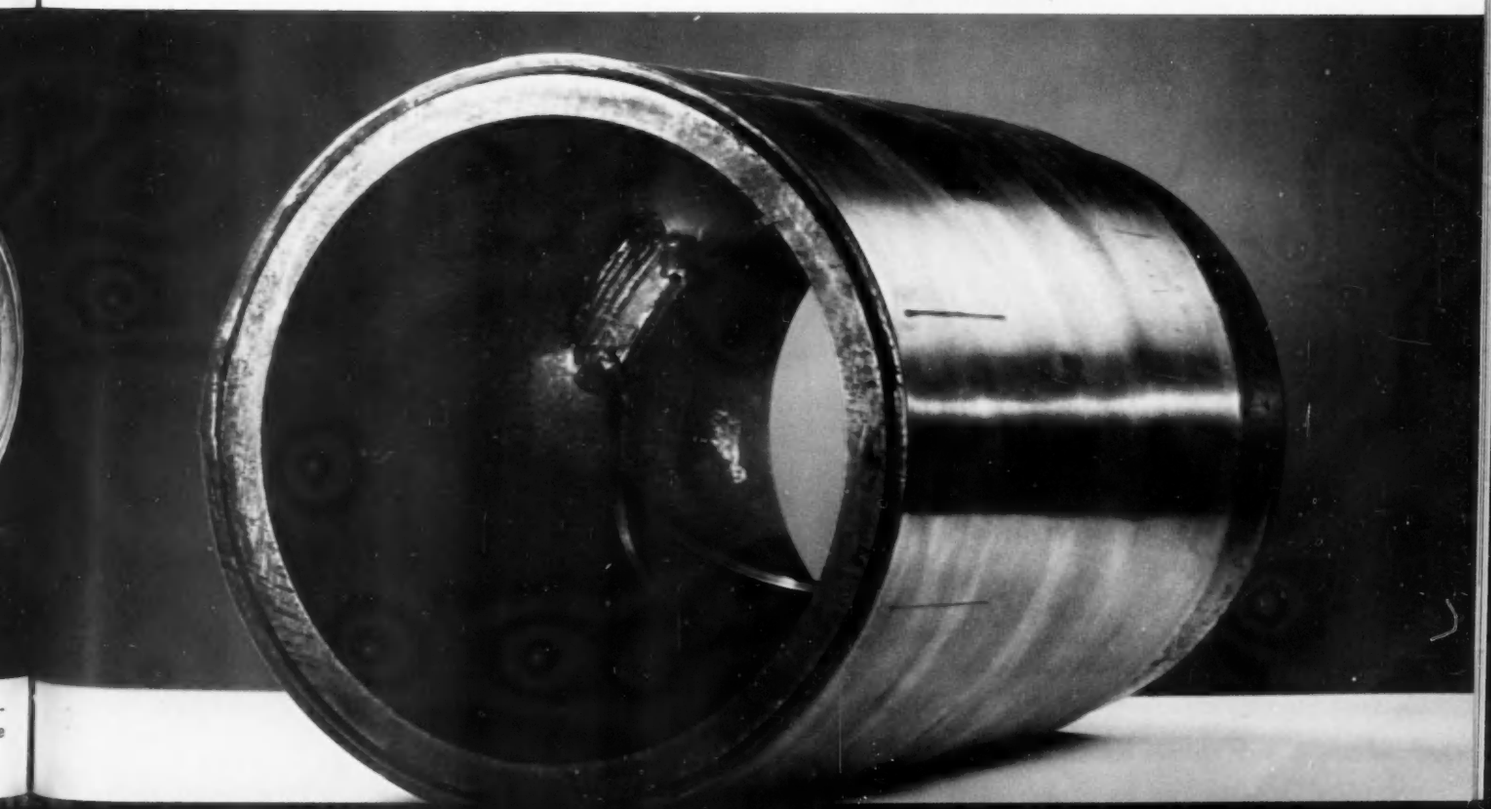
3. **Inside coupling.** Threads torn loose, sections of casing completely deformed, but the coupling did not fail.

BEFORE ↑

A National Super Deep-Well Coupling, containing two sections of 7⅝" O.D. Deep-Well Casing with Buttress-Thread. Each section projects 2" from coupling.

The power hammer has driven one section of the casing into the coupling to meet with the other section. Both sections are a mass of distorted and twisted steel, yet the casing coupling did not fail.

AFTER ↓



New...from MARSH!

MARSH
Master-mite
SOLENOID VALVES

Small solenoid valves that Fill a BIG order

Yes, a series of small, direct acting solenoid valves that fulfill today's critical requirements for rugged, positive-acting tight-seating valves in types, patterns, orifice sizes and electrical ratings for use on a particularly wide variety of media including air, water, petroleum products, coolant, oxygen, hydrogen and acetylene.

They are new only in the production sense. Actually this announcement was preceded by long development and research which drew on more than 90 years of experience in instrument and valve making.

The net result is a valve that combines instrument-precision with the ruggedness that distinguishes all Marsh Valve Specialties!

Despite their small size, "Master-mite" Solenoid Valves are more rugged because the "beef" is where it counts—in the valve body. The generous, moisture-resistant coils do not overheat. Entire assembly is leak-tight at pressures up to 540 psi. Operation is positive . . . yet quiet. Valves can be cleaned without breaking connections . . . can be used in any position.

Bodies are available in either brass bar stock or 18-8 stainless steel. All parts in contact with media are stainless steel. Down to the last detail, "Master-mite" solenoid valves are designed and built to stand up and work right under the toughest conditions including vibration. They are Underwriters' approved for use on oxygen and hydrogen and as safety valves.

Read the accompanying specifications. Note the wide range of selection. Ask for bulletin containing all details.

Note these specifications

- ★ **Types:** Direct acting conduit type and grommet type. Four patterns of each size and type: globe, bottom outlet, angle left, and angle right.
- ★ **Sizes:** ⅛" and ¼" NPT.
- ★ **Pressures:** From vacuum to 540 psi. maximum.
- ★ **Orifice sizes:** Ten sizes: 3/64", 1/16", 5/64", 3/32", 7/64", 1/8", 9/64", 5/32", 3/16", 1/4".
- ★ **Voltages:** Standard with 115 volts 50/60 cycle AC coils, but also available in 12, 24, 208, 230 and 460V, 50/60 cycle coils.
- ★ **Leads:** Standard with 18", but other lengths available; also full range of connectors.
- ★ **Body:** Brass bar stock or 18-8 stainless steel.
- ★ **Moving parts:** All stainless steel.
- ★ **Seat disc:** Synthetic rubber.
- ★ **Approved by Underwriters' Laboratories as a safety valve.**

New bulletin tells the whole story

Shows all types, patterns, sizes, coils, options, etc., and contains highly useful flow curves.

MARSH INSTRUMENT COMPANY
Dept. K, Skokie, Illinois
Division of Colorado Oil and Gas Corporation
Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta, Canada, Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas.

Season's Greetings

FROM AN
OLD FRIEND
WITH A
NEW NAME

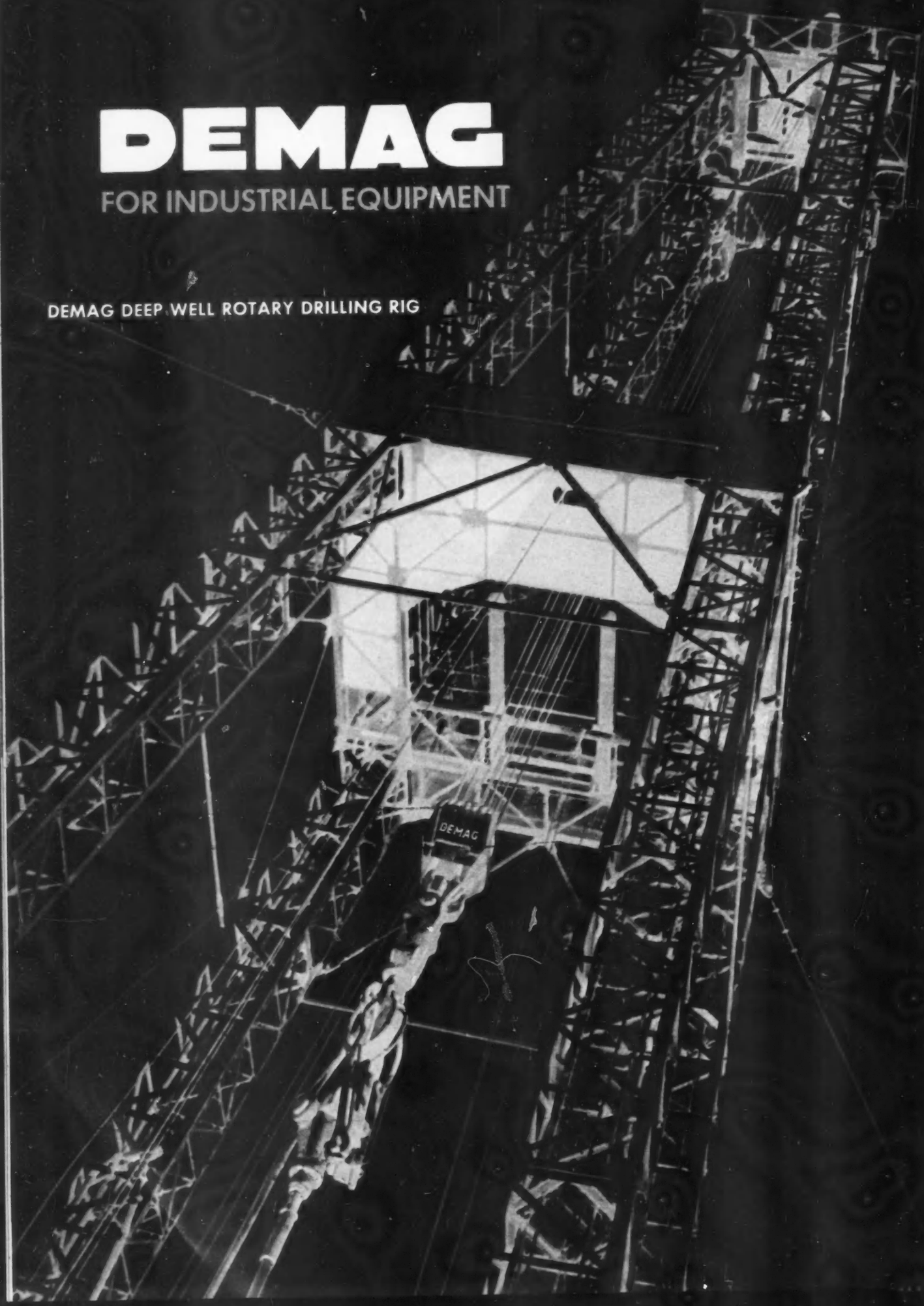
Smith TOOL CO.

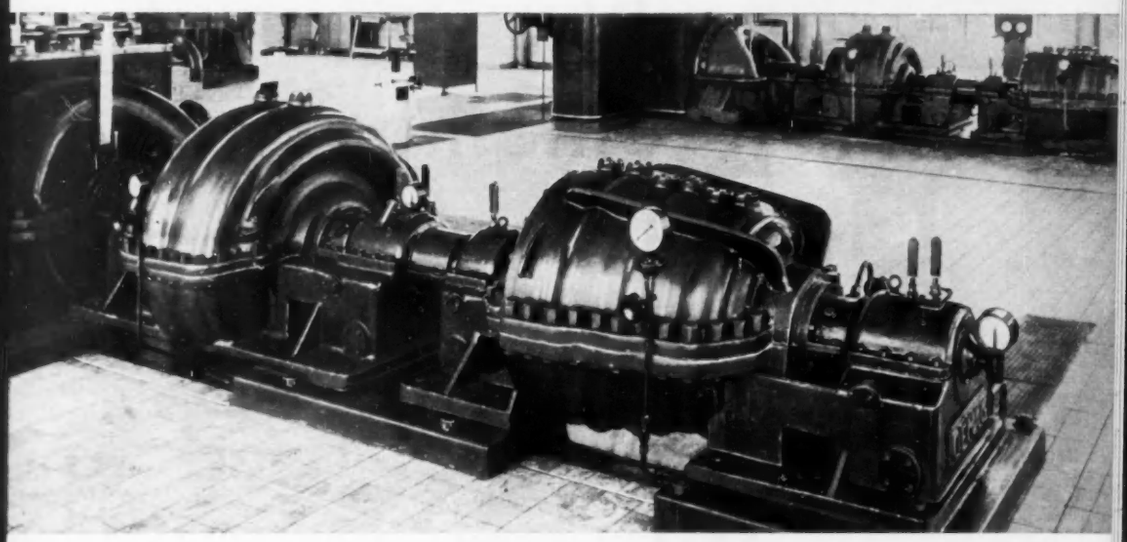
(FORMERLY H C Smith OIL TOOL CO)

DEMAG

FOR INDUSTRIAL EQUIPMENT

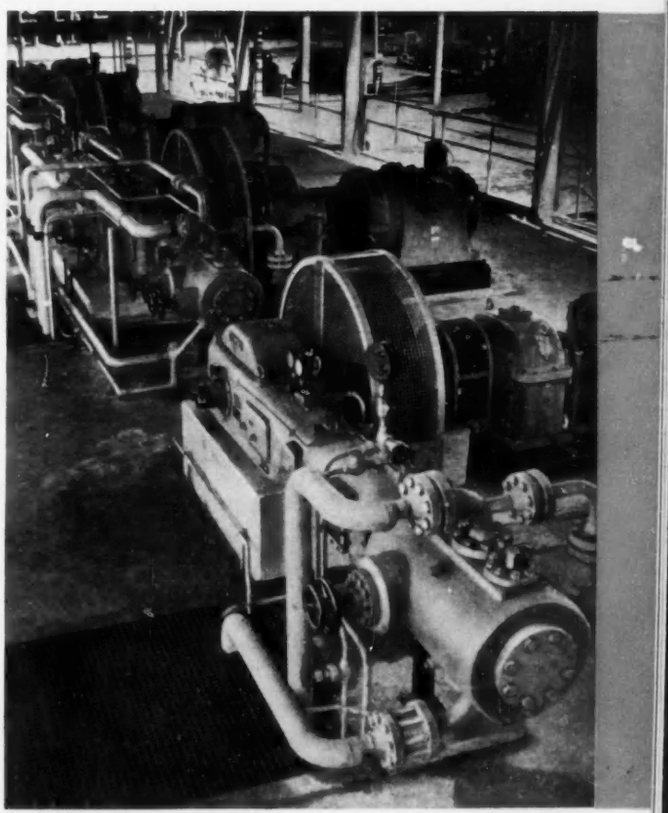
DEMAG DEEP WELL ROTARY DRILLING RIG





DEMAG twin-housing turbo-compressors being used to compress hydrocarbon gas at a German refinery.

DEMAG, in addition to planning and designing machinery and equipment for the metallurgical industry, has for years developed efficient oil field equipment, supplying deep well drilling outfits and compressors to many countries in Europe and overseas.



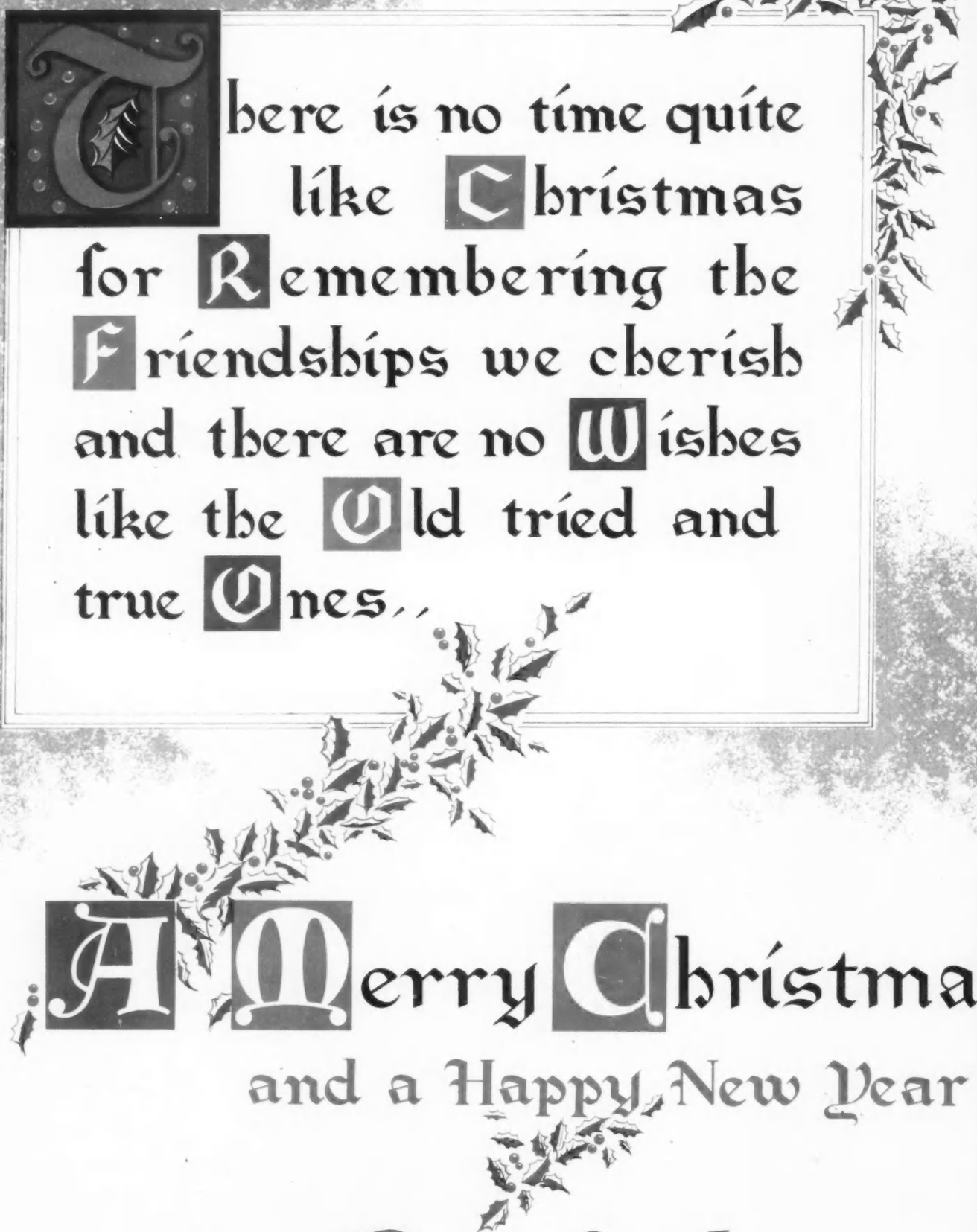
DEMAG non-lubricated horizontal opposed single-axis reciprocating compressors compressing hydrocarbon gas mixtures at a big Dutch refinery.

DEMAG Deep Well Rotary Drilling Rigs, designed on the unit construction principle, are noted for their chainless drives and four-mast derricks.

DEMAG has a comprehensive compressor manufacturing program of models for every application, delivery volume and pressure, and for any type of gas.

DEMAG · DUISBURG · GERMANY

U. S. - Representatives: AMERICAN DEMAG CORPORATION, One Gateway Center, Pittsburgh 22, Pa.


There is no time quite
like Christmas
for Remembering the
Friendships we cherish
and there are no Wishes
like the Old tried and
true Ones..
A Merry Christmas
and a Happy New Year
THE Bovaird
SUPPLY COMPANY

ISN'T IT ODD ABOUT MONEY?

Money may be made of paper, but if it is professionally handled it will support an awfully heavy load. Like an insurance program.

An insurance program, *any* insurance program, is only as strong as the company behind it. Perhaps that is why employers in Texas buy more workmen's compensation from Texas Employers' Insurance Association than from any other insurance company . . . financial strength and stability are TEIA's hallmark*.

**Surplus for the protection of policyholders as of June 30, 1959. $9,200,217.78.*

TEXAS EMPLOYERS' INSURANCE ASSOCIATION

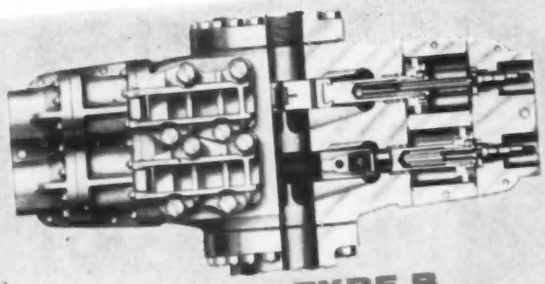
First Choice of Texas Industry for 45 Years

HOME OFFICE: DALLAS | 15 SERVICE OFFICES IN TEXAS | AUSTIN F. ALLEN, CHAIRMAN OF THE BOARD | BEN H. MITCHELL, PRESIDENT

THE TWO SHAFFER BLOWOUT PREVENTERS

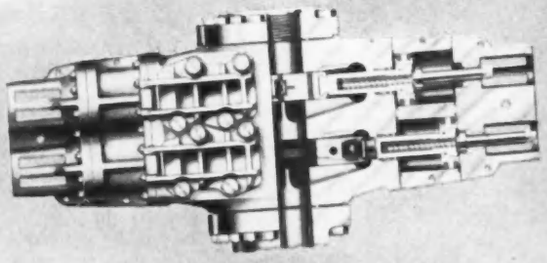
Preferred by Leading Operators!

When you buy blowout preventers you want to be certain you (1) get equipment that has been proven dependable under a *wide range* of operating conditions... (2) get equipment that is easy to service and maintain... and (3) get equipment that embodies *all* the advanced operating features in a compact space-saving design. For the great majority* of today's drilling operations, no blowout preventers offer a more outstanding combination of operating and safety advantages than do the Shaffer Type B Blowout Preventers and the Shaffer Type E Blowout Preventers shown below...



SHAFFER TYPE B BLOWOUT PREVENTERS

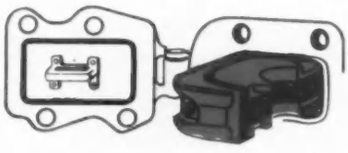
These are the units to use where emphasis is on maximum compactness in the sub-floor hook-up. Type B Preventers have *non-rising* locking shafts —therefore, are ideal where tight end clearances are a problem. Other than non-rising locking shafts, Type B Preventers share with Type E Preventers the same operating advantages outlined below.



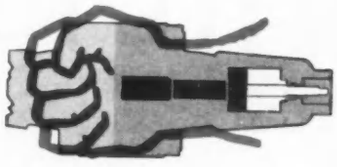
SHAFFER TYPE E BLOWOUT PREVENTERS

These are the units to use where end clearances are no problem and where it is desired to check ram positions by a quick look at the position of the *rising* locking shafts. Other than the rising locking shafts —which require somewhat greater body length— Type E Preventers share with Type B Preventers the same operating advantages outlined below.

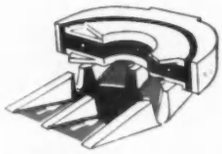
UNIQUE FEATURES BUILT INTO **BOTH** TYPE B AND TYPE E PREVENTERS



"SWING-OPEN" RAM DOORS: No need to dismantle Shaffer Preventers to change rams. With Type B and Type E Gates, you simply unbolt side-opening doors, swing open, change rams and bolt shut. It's quick and easy!



POSITIVE "IN-LINE" POWER DRIVE: There are no levers, yokes or complicated connections to jam... no "arm pockets" to clog with cement or mud... nothing to jeopardize quick ram operation when emergencies threaten!



QUICK-DRAIN RAM COMPARTMENTS: Steeply-sloped compartment bottoms drain sand and mud back into the well. Rams travel on raised guide ribs, high above any detrimental accumulations left by drilling fluids.

SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

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OKLAHOMA CITY, OKLAHOMA, Shaffer Tool Works, 6201 South Shields Boulevard
FARMINGTON, NEW MEXICO, Shaffer Tool Works, Post Office Box 546
CASPER, WYOMING, Shaffer Tool Works, Post Office Box 1788
HOUMA, LOUISIANA, Shaffer Tool Works, Post Office Box 827
EXPORT SALES OFFICE: Shaffer Tool Works, 500 Fifth Avenue, New York, N. Y., U.S.A.

36 years OF OIL TOOL LEADERSHIP

There are many other important advantages built into Shaffer Blowout Preventers. Your nearest Shaffer representative will gladly give you full details. *Or write direct!*

* ***REMEMBER***

also, Shaffer Type **XHP** Preventers for *Extra High* well pressures... and Type **LWS** Preventers for lightweight portability on

These are the wind swept mountains of coastal Alaska *where everything works against the geophysicists' summertime searches. Here, in the summer of 1959, one particular 20 man geophysical party moved with exceptional speed and safety. Why?... because a new Hiller 12 E, operated by Livingston Air Service of Corvallis, Oregon, moved and supported them. This new helicopter doubled the payload any other light utility helicopter had ever been able to carry on identical jobs.*

Specifically, the 12 E's typical payload was a two man survey team, all their equipment, and a 150 lb. drill, plus explosives. Multiply that by the entire 20 man team and you see why the head geologist and party chief called it..."the best helicopter buy in Alaska this summer."

In the arctic or the tropics, timberline or shoreline, the 12 E's performance will pay off on important jobs in your operations–exploration, offshore taxi and supply, pipeline construction and many more.

The Hiller 12 E is the most powerful helicopter in its class; its 305 usable horsepower actually matches the power of all but the very largest bulldozer. Put this rugged, dependable helicopter in the sure hands of a Hiller Charter Operator and you have a truly economical service.

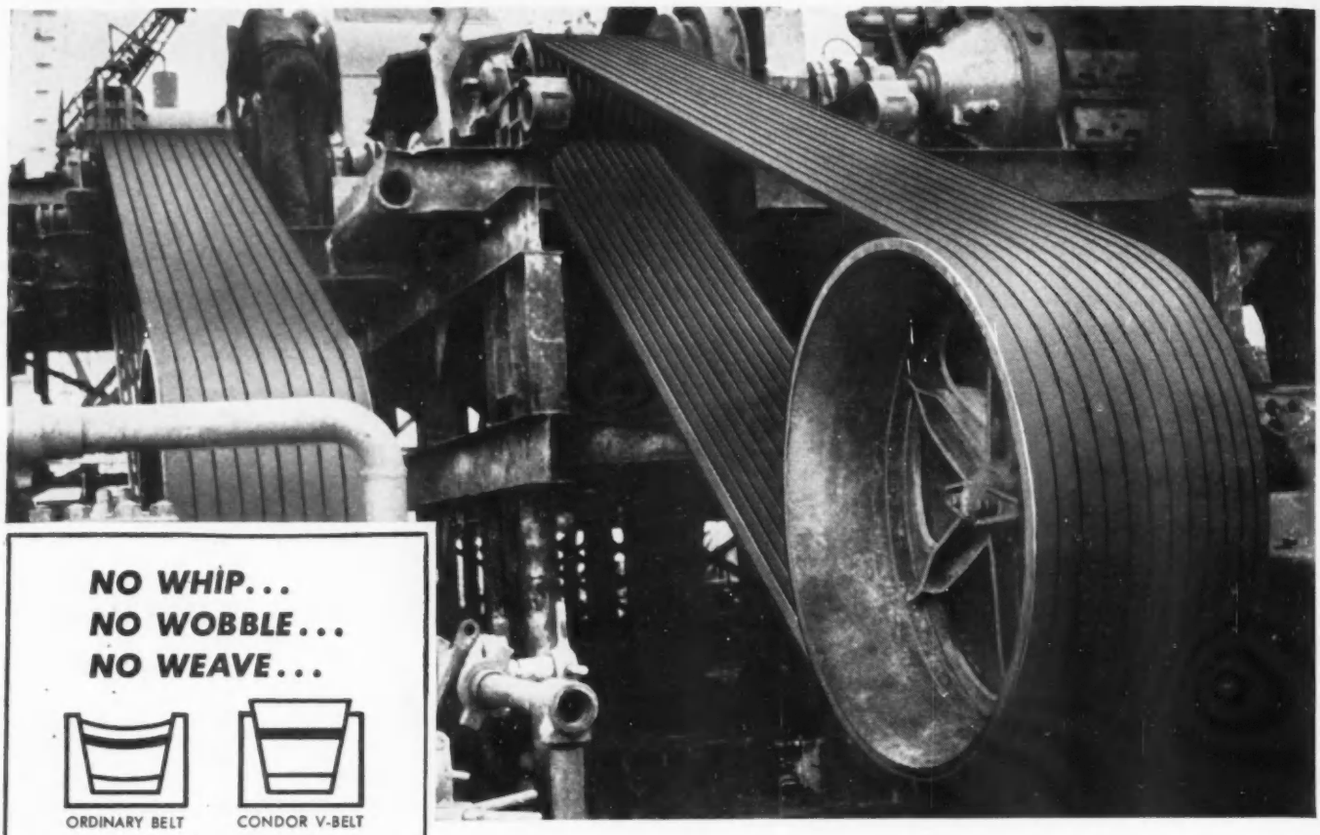
He invests *in the best aircraft available so* ***you*** *can have the convenience and economy of chartering by the flight or by the contract. It's worth looking into. You'll know right away whether the 12 E will make substantial savings in your operation. Write today for free literature, "New Workhorse for Petroleum," Commercial Division*

HILLER
AIRCRAFT
CORPORATION
PALO ALTO, CALIFORNIA

EXPORT SALES OFFICE: Shaffer Tool Works,

lightweight portability on

Wherever oil men work, they depend on



NO WHIP...
NO WOBBLE...
NO WEAVE...

ORDINARY BELT CONDOR V-BELT

Note how flat sidewalls in Condor at right prevent sag in "power line".

CONDOR LS V-BELTS COME MATCHED TO STAY!

Top to bottom, *every* part of a Condor LS Belt is "length stabilized" ... engineered to minimize belt stretch and eliminate whip and turnover that leads to belt failure.

- **New "Stabilizing" Section**
- **Repositioned Belt Strength Members**
- **Length Stability *Without* Stretch**
- **Smoother, Cooler Running**

Plus

- **Moisture-Proof Vacuum Packaging**

Each Section C and D long-center belt is measured under controlled humidity . . . length certified and tagged . . . then vacuum-sealed in aluminum-lined, moisture-proof bags. Result? Factory-fresh belts—positive matching—no shrinkage or elongation in storage . . . sustained uniformity on your drive!

Write for Bulletin #M210

..."MORE USE PER DOLLAR"

THESE CONDOR LS* V-BELTS ARE DELIVERING 40% MORE HP

Continued improvements in Raybestos-Manhattan's Condor V-Belt over the years have resulted in an engineering advance of major importance to users of long-center V-belts. The Condor LS V-Belts you install today have the 40% greater power capacity formerly available only in a *premium* V-belt construction . . . *without* the premium price!

R/M engineering utilizes special super-strength synthetic fabric strength members in Condor LS V-Belts. Micro-positioned in special heat dissipating rubber and with flat sidewalls, they make possible an average of 40% more power capacity and longer life . . . assure a smoother, cooler running drive even under shock loads.

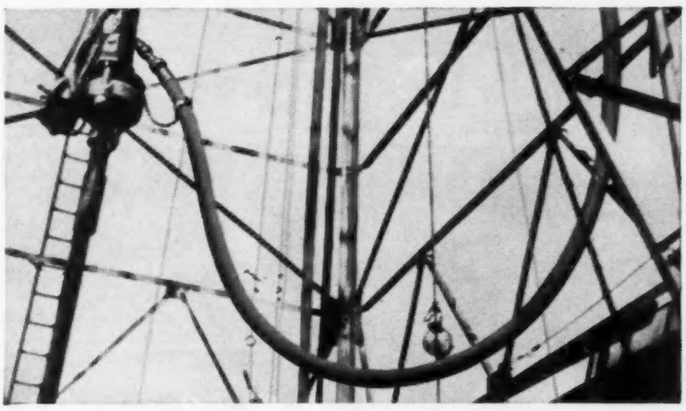
Chances are the Condor LS V-Belts in your inventory have this 40% reserve power capacity. Be certain the *next* belts you buy are Condor LS V-Belts . . . the premium V-belt construction at the standard V-belt price.

R/M

OTHER RUBBER PRODUCTS FOR THE PETROLEUM INDUSTRY

MUD PUMP INTAKE HOSE • VIBRATION HOSE • SHIP AND BARGE LOADING HOSE • TANK TRUCK AND TANK CAR HOSE • PROPANE HOSE • FUEL OIL TRUCK HOSE • FIRE HOSE

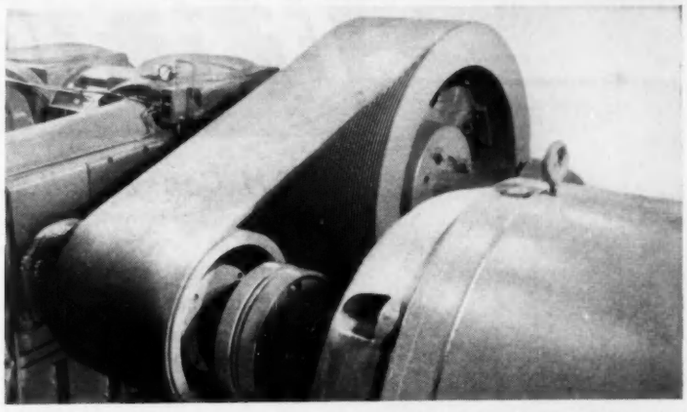
R/M Products



RAY-MAN ROTARY HOSE

Strong • Safe • Flexible

Special high-tensile steel cable wire reinforcement, precision wound under tension, gives Ray-Man CBL Rotary Hose unequalled strength and flexibility for safer, easier handling and make-up on the rig. Resists kinking and accidental crushing in transport . . . holds steadier in the derrick *without whipping*—even under high pressures of deep drilling. Streamlined, built-in coupling has no protruding lugs or flanges—features R/M leak-proof "Lip-Lok" seal that tightens under pressure to prevent blowouts! Write for Oilfield Hose Bulletin M651.

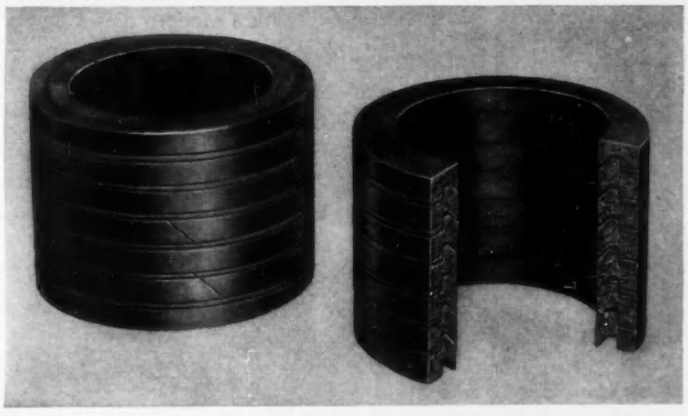


R/M POLY-V® DRIVES

More Power • Less Space

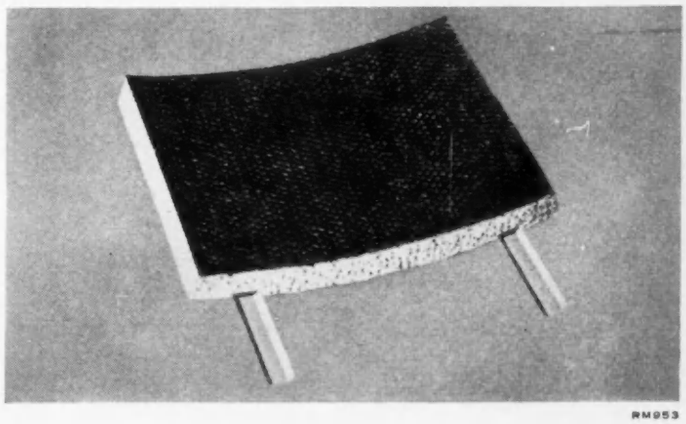
No other drive puts as much extra push in deep hole drilling as the exclusive, patented R/M Poly-V! Delivers up to 50% more power capacity than a V-drive of equal width . . . or equal power in as little as ⅔ the width. Single unit belt design eliminates belt matching problems in the field . . . reduces field inventories. Just *two* belt cross sections meet every heavy duty drive requirement. Write for Poly-V* Drive Bulletin M141.

**Poly-V is a registered Raybestos-Manhattan trademark. Patented.*



R/M VEE-SQUARE® PACKINGS FOR MUD PUMPS

Depend on R/M Vee-Square Packings for extra reliability. Nonyielding, they can take tight gland pressure, require no sensitive gland adjustments. Blow-by is prevented by soft rubber cushions between the rings, and they seal automatically. R/M "Vee-Square" packing is manufactured for all types and sizes of oilfield mud pumps. Write for Hydraulic Packings Booklet.



RAY-MAN BRAKE BLOCKS

Long lasting Ray-Man 635-D Brake Blocks cost less because they wear longer. Made of extra-large asbestos yarns, special saturant, wire reinforced. Resist bleeding, won't glaze or carbonize. Ray-Man blocks are available in drilled or countersunk sets or in the R/M patented Key-Lok style. Patented key-lok gives more friction surface, blocks slide on and off to speed relining. Make hole faster. Cut cost with Ray-Man. Call your nearest R/M warehouse today or contact your closest authorized R/M oilfield equipment supply store located in major oil producing areas.

RM953

RAYBESTOS-MANHATTAN, INC.

PASSAIC, NEW JERSEY

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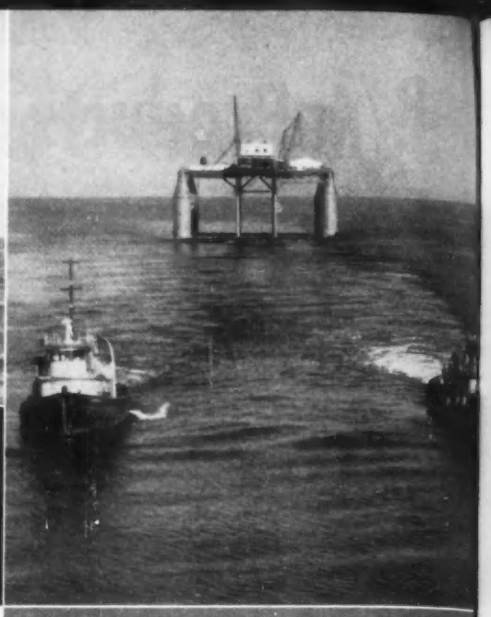


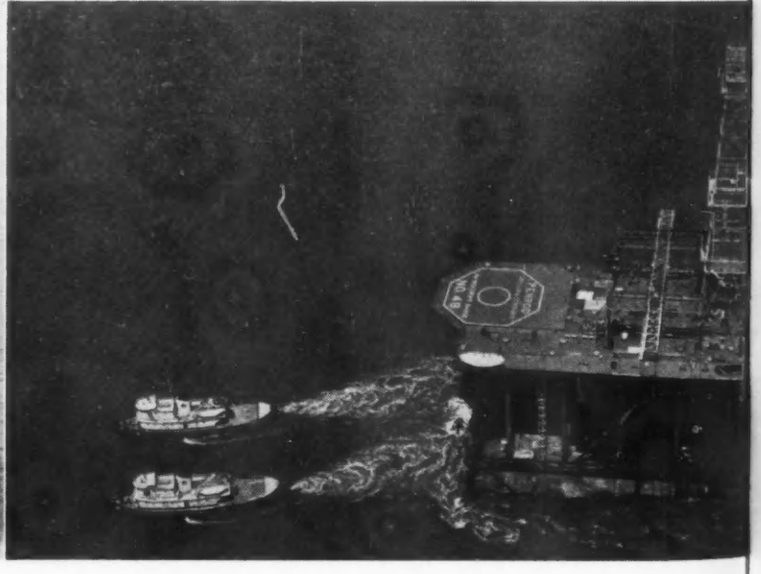
If it floats,

G&H Can Tow It... Anytime, Anywhere

Pioneers in Gulf Coast tidelands towing, G & H has capably handled every conceivable towing assignment . . . with speed, safety, efficiency, and ultimate economy to your offshore operating program.

With a modern diesel fleet of 700 to 1700 hp tugboats, for every towing requirement . . . and over 35 years of diversified marine experience . . . G & H can expediently tow anything that floats . . . anytime, anywhere.

Call the G & H office nearest you today, and let towing experts help you plan your next offshore moving job.



G and H

DAY OR NIGHT PHONE
Galveston SO 3-6468 or SO 3-4673 • Houston WA 8-5406 or MI 5-3814
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FLEET OF MODERN 700 TO 1700 HP TUGBOATS FOR EVERY TOWING REQUIREMENT

Corpus Christi • Houston • GALVESTON, 509 Texas Building • New Orleans

A BETTER LOGGING BLOCK!

SUPERIOR McKISSICK FEATURES

- Extra large double row, pre-a sted Timken bearings.
- Johns-Manville "Klipper" grease seals, effectively seal in lubricant at high speeds.
- Alloy steel flame hardened sheaves, machine grooved for proper size armored logging cable.
- Quick opening pin for fast stringing up, light weight for easy man-handling, Alemite lubrication.
- Tenzalloy aluminum housings for maximum strength and minimum weight.

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REELS

EHS-1520

EH-1816 with Type C Measure Meter

Drillers and Producers Choose . . .

Mathey Measuring Line Reels for bottom hole pressures, temperature surveys, calipering, paraffin cutting, sampling and many other wire line jobs. Mathey Reels are made to meet your requirements of line speed, pull, capacity and type of power. Mathey's years of experience guarantee you heavy duty construction, precision machining, oversize bearings and forged steel drum flanges. Specialty reels can be engineered and manufactured. Call or write for further information.

SOLD THROUGH YOUR FAVORITE SUPPLY STORE

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Down Hole Reaming

You can get from Grant!

When you order out your next Reamer—*call Grant*. Different well conditions, different formation, depth and drilling requirements, and even different preferences have resulted in *three* distinct Grant Reamer types to meet *every* need. Then add

Six cutter types for every formation
Three, six or *nine* point body styles
Size ranges for *all* hole diameters

and you have an unlimited selection of Grant Reamers for reaming any well you drill . . . stocked and serviced by Grant in active areas *everywhere.*

It pays to ream *right*. And to use the *right* reamer, call Grant—*because only Grant makes them all!*

This is just one of the three *families* of Grant Tools made for reaming, hole enlarging and stabilizing. For full information on these, and a wide range of other down-hole and surface tools made by Grant, send for your copy of the complete Grant Catalog today, or see the Grant section of Composite Catalog!

GRANT OIL TOOL COMPANY

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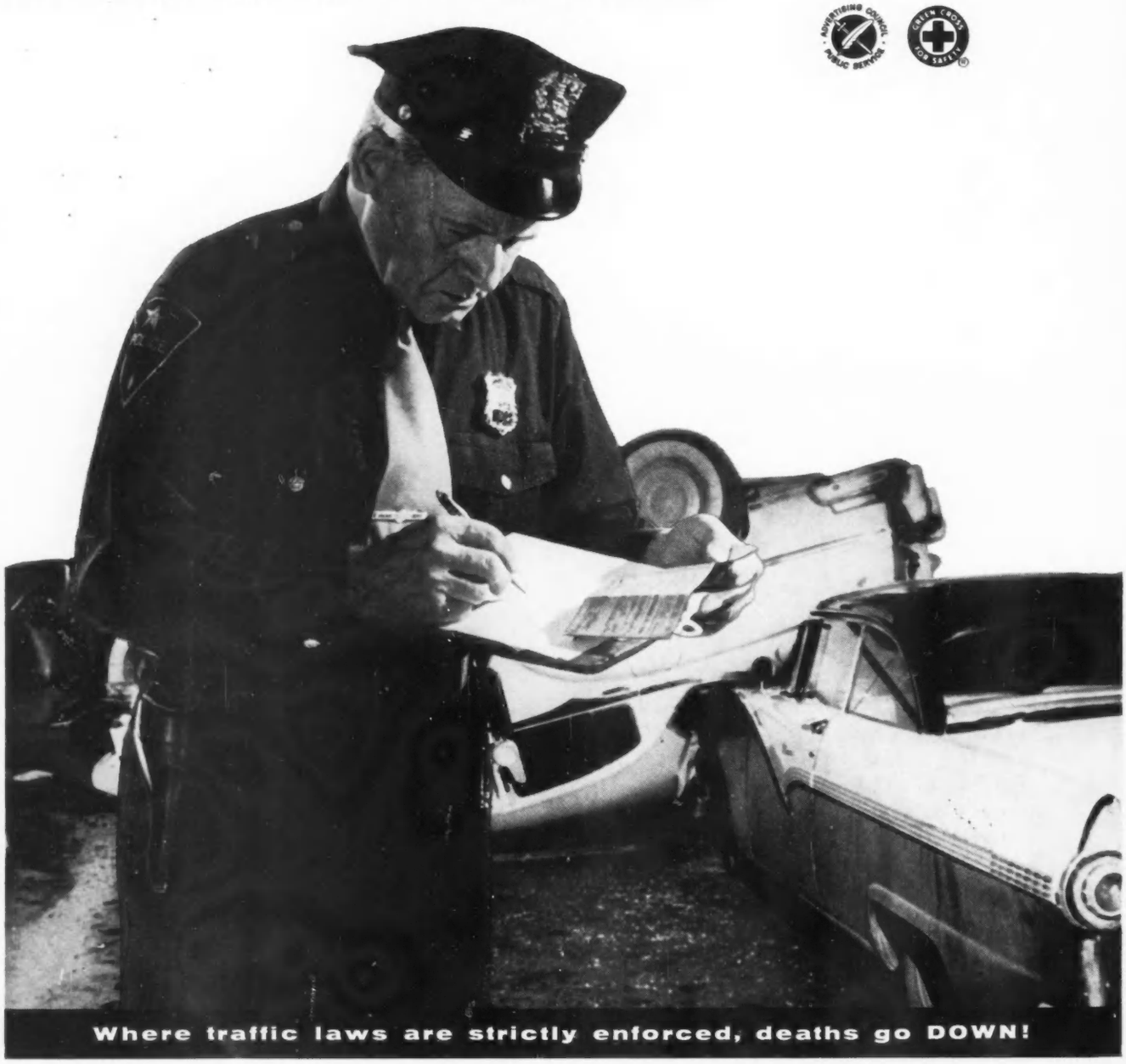
Last year, traffic accidents killed 37,000, injured 1,400,000

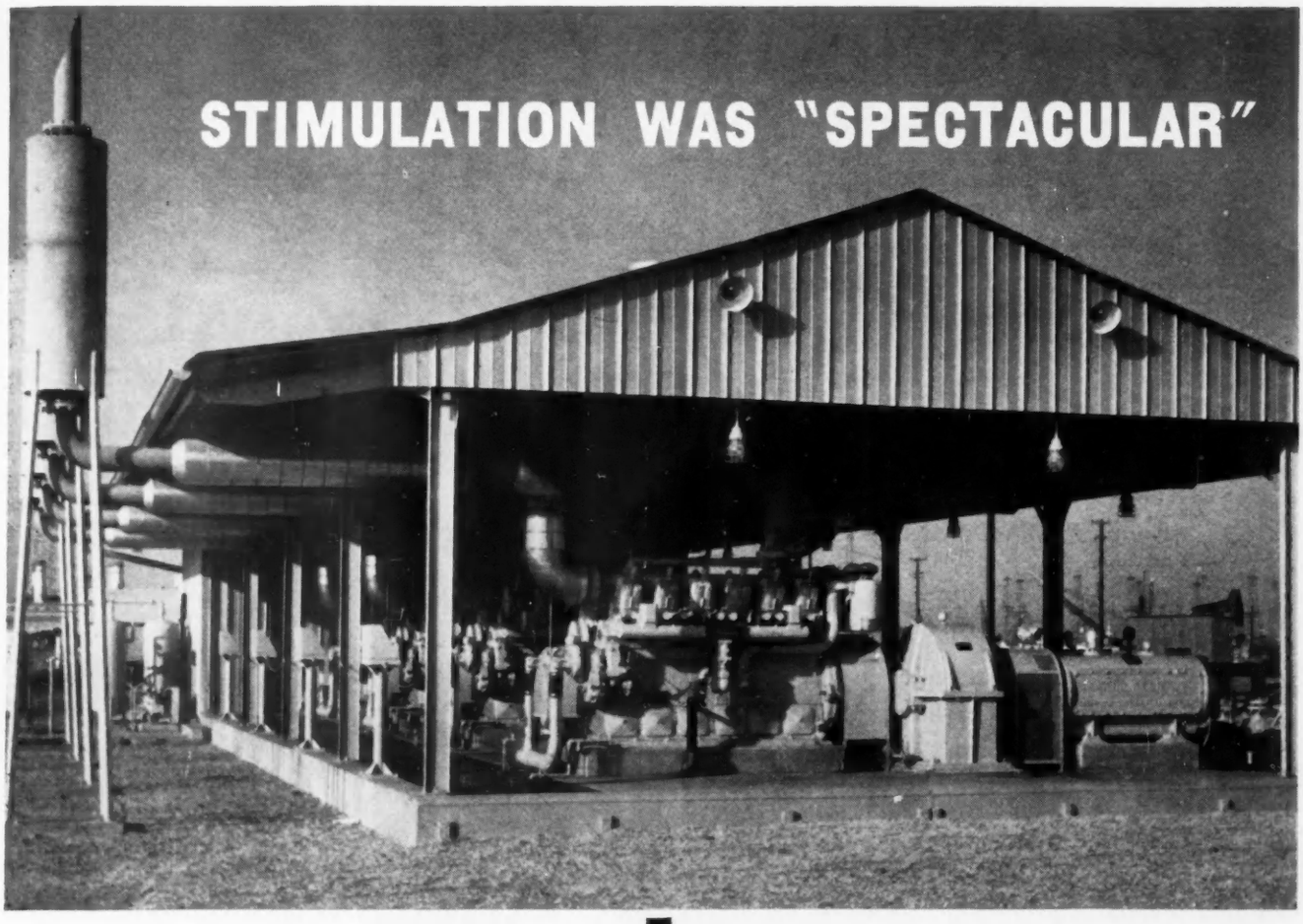
. . . and they wasted Five Billion Dollars!

Traffic accidents' human toll is so tragic we sometimes overlook their staggering economic waste. Five Billion Dollars in lost wages, medical expenses, insurance costs and property damage! Your business—every business—shares in this loss. So you have a double interest in helping reduce traffic accidents. And you *can* help! Drive safely and obey the law yourself . . . certainly. But go further. Use your influence to promote safe driving and urge strict law enforcement. To make your efforts more effective, join with others working actively to reduce traffic hazards in your community. *Support your local Safety Council!*



Where traffic laws are strictly enforced, deaths go DOWN!

Published in an effort to save lives, in cooperation with the National Safety Council and The Advertising Council.



waterflooding at Long Beach with WAUKESHAS

The waterflood repressuring project—under Long Beach City property, in the Wilmington California Oil Field—is probably the country's largest. The Waukesha-Engine-powered Pier E station is the project's second water injection plant. Ten months after its activation, stimulation observed was "spectacular" as one expert put it.

Four Waukesha V-12 natural gas engines drive four Oilwell 558-P Quintuplex Plunger Pumps. Each pump delivers a volume of 20,400 bpd of salt water at a pressure of 1270 psi—at 175 rpm max., with 5-in. diam. plungers. The pumps can operate at 2000 psi, with 4-in. plungers, and deliver 11,150 bpd.

The four Waukeshas are Model VLROB natural gas engines, 12-cylinder, 8½ x 8½-inch bore and stroke, 5788 cu. in. displ. Engines are set to max. full load speed of 1020 rpm to give approx. pump speed of 175 rpm driving through speed reducers with 5.857:1 ratio.

These Waukesha Engines are equipped with S-69 Western Gear speed reducers; Ross 1204-CP Heat Exchangers; couplings—engine to reduction gears, 28-CB-525 Fawick—gears to pump, Fasts No. 6.

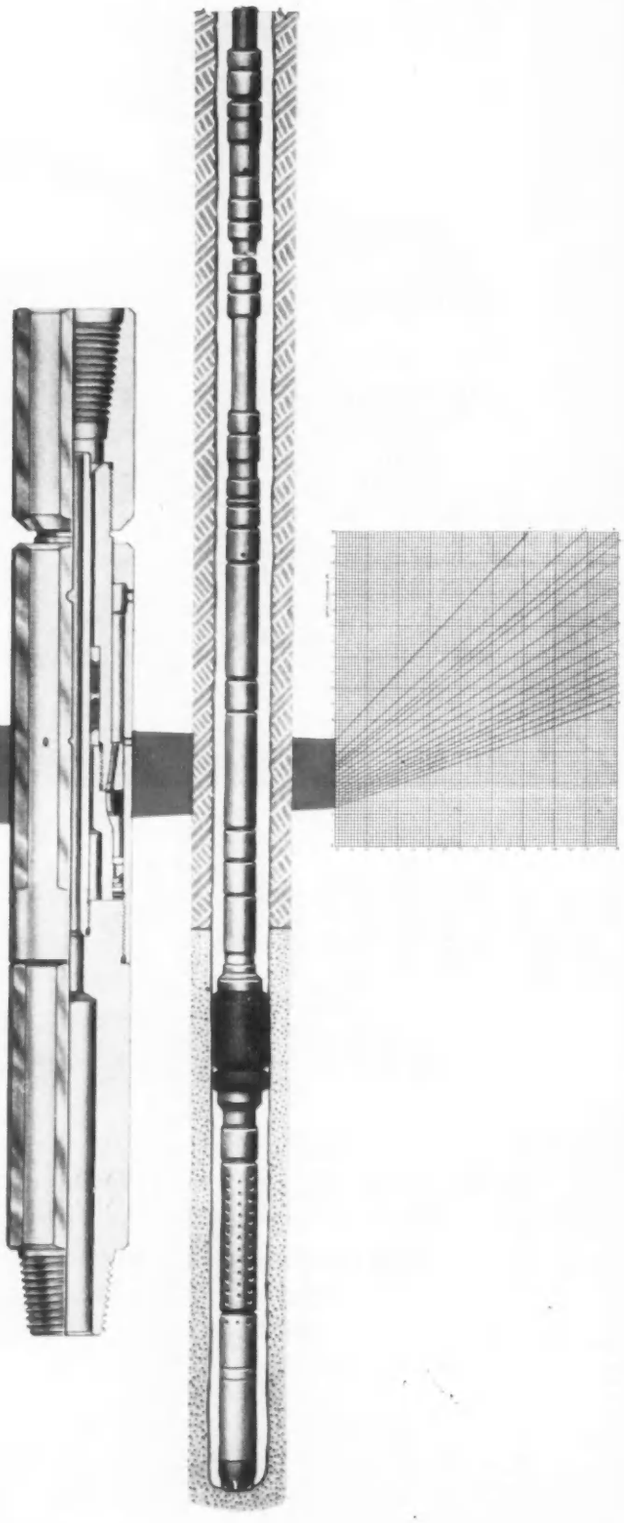
Send for Waukesha Bulletin 1656.

450

WAUKESHA MOTOR COMPANY, WAUKESHA, WISCONSIN / **New York • Tulsa • Los Angeles**
Factories: Waukesha, Wisconsin and Clinton, Iowa

STRIKING POWER *proves* HALLIBURTON HYDRAULIC JAR BETTER!

Halliburton's rugged and reliable Hydraulic Jar combines effective action with simplicity and ease of operation. By means of this useful tool, the hydrostatic pressure of the well fluid gives a "knock-out" punch to unseat and release stuck packer or anchor. The simplicity of the Hydraulic Jar is demonstrated by its one moving part; its striking power has proven its effective dependability.



CURVE SHOWS HOW THIS STRIKING POWER INCREASES WITH DEPTH . . . EASES STRAIN ON TESTING STRING

When pull is applied to the pipe against resistance, the sealing packer acts as a piston in the hydraulic system of the Jar, working against the hydrostatic pressure of the well fluid. The striking force of the Hydraulic Jar is intensified with depth; an increase in well depth or in hydrostatic pressure increases the strength of the blow. The Hydraulic Jar may be cocked and re-cocked, if required, by slacking off pipe weight, as when packer is set.

See your Halliburton Formation Testing Specialist for details of the Hydraulic Jar and the money-saving rental plan. Put the striking power of Halliburton's Hydraulic Jar to work for you!

HALLIBURTON TESTING SERVICES

HALLIBURTON OIL WELL CEMENTING COMPANY • DUNCAN, OKLAHOMA

THE PACE SETTER IN FORMATION TESTING

ALL OVER THE WORLD

ROLLS-ROYCE

DIESEL ENGINES

SALES DOUBLED

IN

TWELVE MONTHS

ROLLS-ROYCE LIMITED · OIL ENGINE DIVISION · SHREWSBURY, ENGLAND

MONTREAL, CANADA · SYDNEY, AUSTRALIA

ROLLS-ROYCE — AERO ENGINES · MOTOR CARS · DIESEL AND PETROL ENGINES · ROCKET MOTORS · NUCLEAR PROPULSION

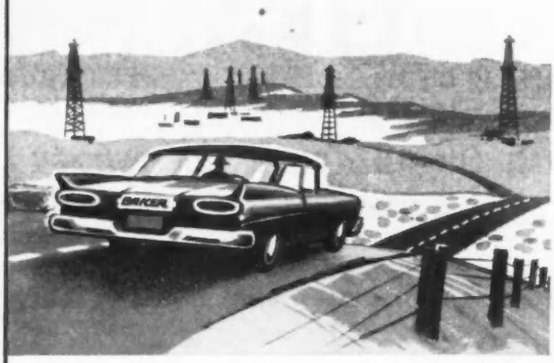
SQUEEZE, FRACTURE, ACIDIZE and TEST with these . . .

DEPENDABLE BAKER SERVICE TOOLS

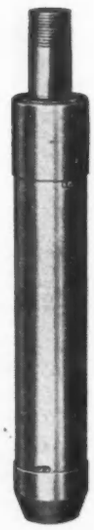
Here is work-over and re-completion SERVICE as you want it—anywhere, anytime—with seasoned Baker Trained Servicemen and Dependable Baker Retrievable or Drillable Service Tools. Baker provides the right tool, or combination of tools, for *any* job, whether it is routine squeeze cementing; block squeezing in one round trip; performing selective multiple-zone frac jobs in *one* run; acidizing, testing, etc. Bridge Plugs, both Drillable and Retrievable, and a variety of accessories for testing tubing, equalizing tubing/annulus pressures, batch squeezing, etc. round out the most complete line of dependable service tools obtainable.

And the Baker Serviceman, who knows his business because Baker Tools are his *only* business, is always available. His knowledge of local field conditions enables him to make sound recommendations for operations in your well. It pays to start right by calling Baker!

BAKER FULL-BORE RETRIEVABLE CEMENTERS permit running through-the-tubing perforating guns, recording instruments, etc., through and below the tool. Opposed, rocker-type slips and a superior packing element ensure pressure containment from either direction. The ideal "straddle" tool when used with a Baker Retrievable Bridge Plug. Call for Product No. 410.



BAKER RETRIEVABLE BRIDGE PLUGS are dependable, and they hold pressure from either direction. Used **alone** for plugging casing temporarily under routine or emergency condition, or in combination with other Baker **RETRIEVABLE** Tools to straddle a virtually unlimited interval. Call for Product No. 677-C.

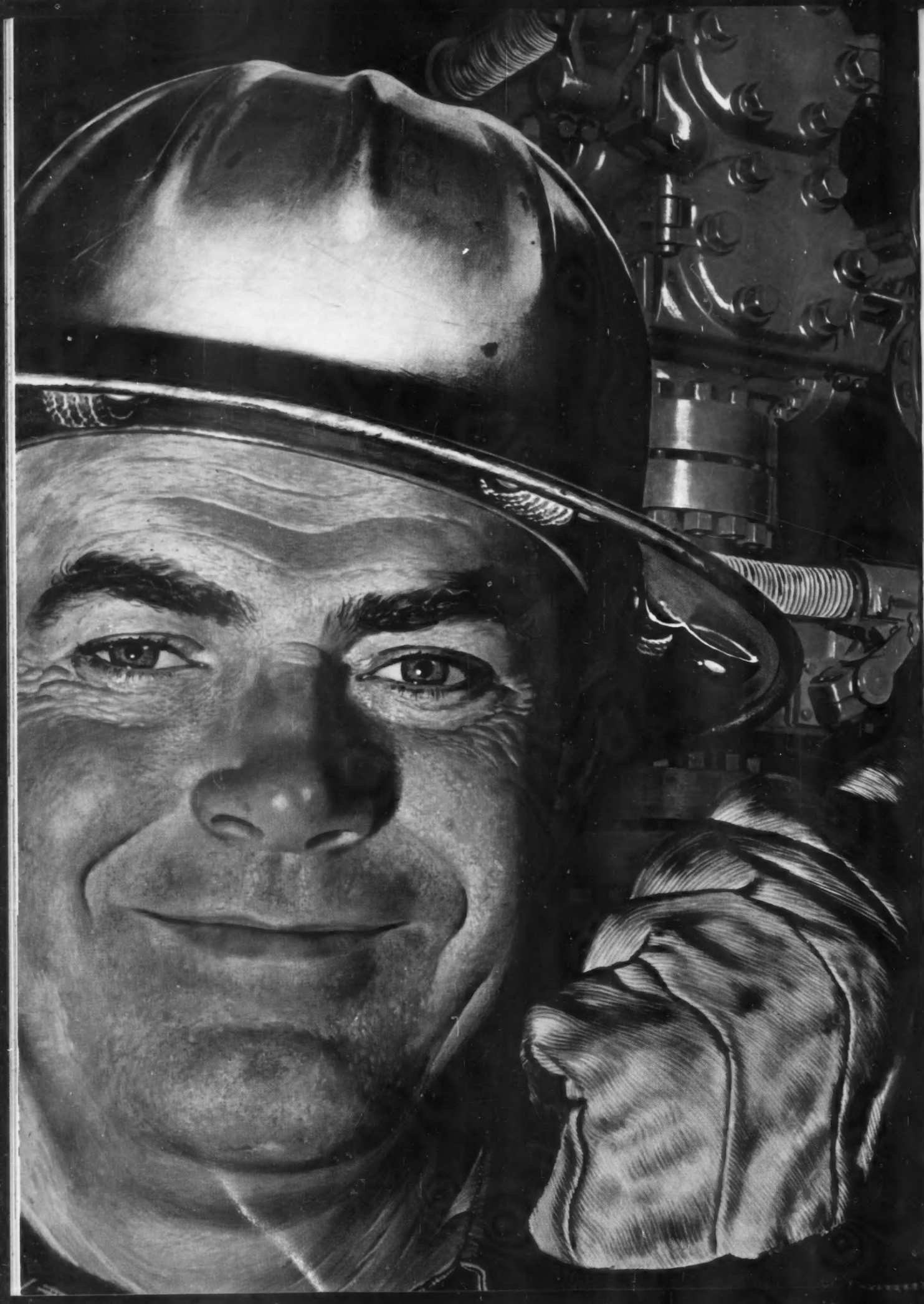


BAKER FULL-BORE TUBING TESTERS are run with Baker FULL-BORE Retrievable Cementers for safe testing of tubing immediately before squeezing. Right-hand rotation required for setting the Cementer, serves to unlock the Tester Valve; set-down weight closes it; picking-up after testing restores full-opening through the Tester. Call for Product No. 672-N.

"No fundamental changes have occurred in the underlying forces which have made the oil industry a good bet for the long pull. Increased populations, increasing living standards, increased industrialization will make it necessary for the free world industry to provide in 1975 something in the order of 14,000,000 barrels a day more oil than were consumed in 1958. This means that by 1975 world oil demand will have increased by about thirteen times Saudi Arabia's current output." — M. J. Rathbone, President

Standard Oil Company (New Jersey)

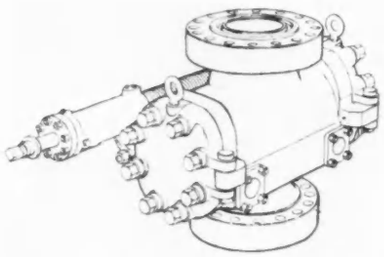
and affiliated companies



"... WITH SO MUCH AT STAKE

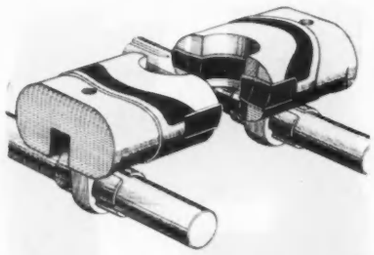
TAKE CAMERON EVERY TIME."

The most important part of your rig can be your blowout preventer system.



Cameron Type "F" Blowout Preventer — latest design in almost 40 years of leadership.

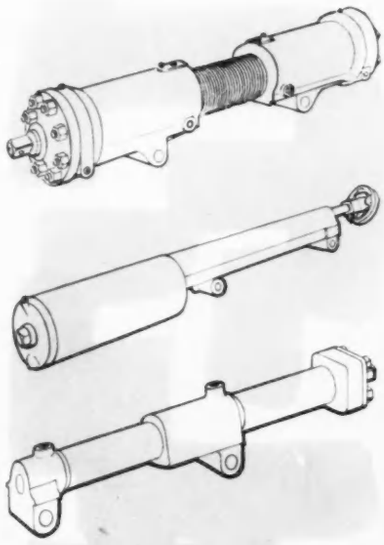
When you are drilling, you're looking for pressure —and higher pressure means higher profit.



Ram actuator shafts rotate — are sealed at both ends to produce pressure balance for extra-easy operation.

But the difference between success and failure can depend on your ability to control down hole pressures.

Since we developed the first successful preventer, almost 40 years ago, a majority of successful operators all over the world have relied on the safety, service and economy of our efficient units.



Type "F" Preventers are available with interchangeable operators for hydraulic, air or manual service.

Cameron Type "F" Preventers are the latest design in our development program, which, incidentally, is continuous at Cameron.

Early in our history as a company it became obvious that intermittent design work cannot meet the rush toward greater depths and higher pressures. As a result, we have always been ready with equipment to handle each new drilling requirement.

Close and continuous observation of pressure problems in drilling has shown that the best Blowout Preventer is the only bargain. This is the reason we say "... with so much at stake, don't take chances, take Cameron every time."

Cameron

IRON WORKS, INC.

P. O. Box 1212 — Houston, Texas

Export Office: 7912 Empire State Bldg., New York City. In England: Cameron Iron Works Ltd., 76 Grosvenor St., London W. 1 England.

Testing **Unaflo** cement slurries above 200°F

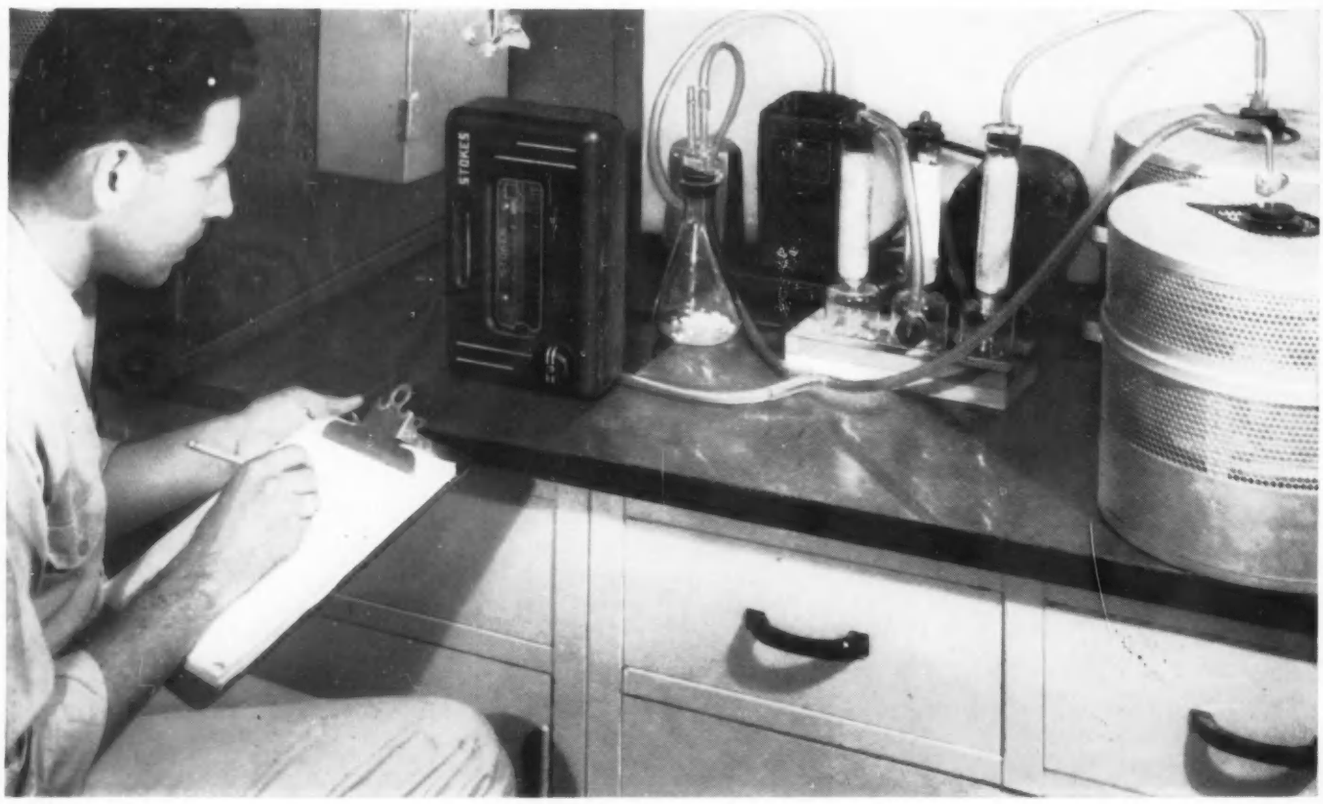
This laboratory technician is studying physical and chemical changes – caused by curing Unaflo retarded oil-well cement slurries at temperatures over 200° F – and at pressures ranging from atmospheric to 7,500 psi.

Hardened neat cement pastes, cured under these conditions, are granulated and then exposed in vacuum desiccators to chemicals having various vapor pressures. The moisture absorbed under these conditions provides a means for determining the surface area of the hardened paste.

This is another research procedure developed at our laboratories to investigate the properties of Unaflo cement under deep-well conditions.

For more information on Unaflo retarded oil-well cement, write Universal Atlas, 100 Park Avenue, New York 17, N. Y.

"USS" and "Unaflo" are registered trademarks.



U-158

Universal Atlas Cement
Division of
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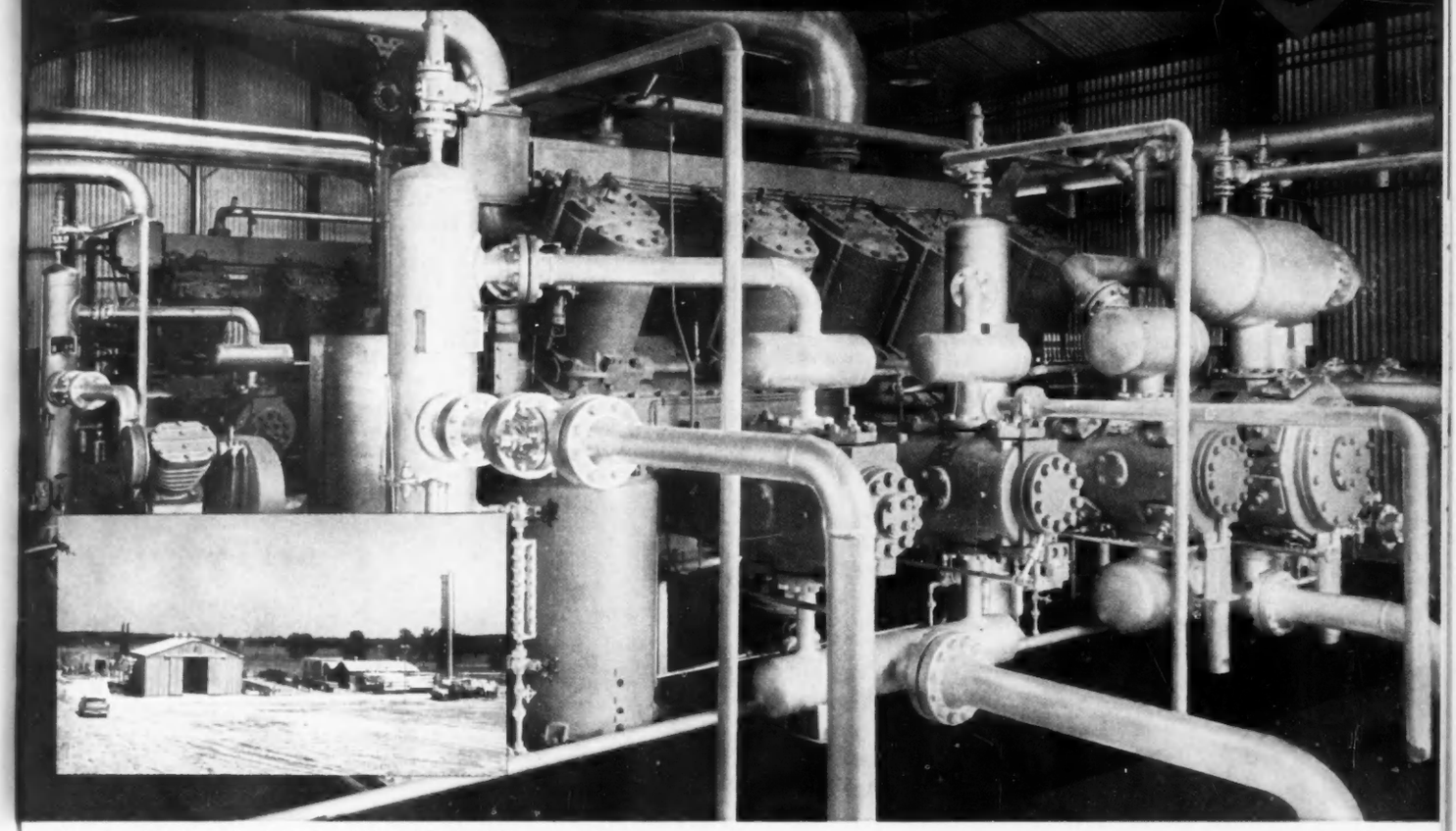
BEAIRD-INGERSOLL-RAND Packaged Compressor Plant



Tatum Gas Plant equipped with two Beaird-Ingersoll-Rand 10SVG 550 h.p. packaged compressors. Units are complete with all necessary controls for unattended operation. Other sizes from 120 to 660 h.p.

Packaged Compressor Equipped . . .

GAS PROCESSING BOOSTS FIELD ALLOWABLES

Robert Cargill, operates this gas processing plant in the Tatum-Petit Field. Located just outside the city limits of Tatum, Texas, the field has grown from a single wildcat to 75 producing wells in less than three years. During this swift expansion it became evident that the increasing number of high gas-oil ratio wells would curtail oil production unless a means was provided to conserve the excess gas. An additional problem was created by the wide variation of wellhead pressures which ranged from 25 psig. to 650 psig.

Engineers called in by Robert Cargill solved the production problem by designing a gas processing plant to remove heavy elements as marketable by-products and to boost the dry gas to a nearby sales line. Two Beaird-Ingersoll-Rand 10SVG 550 horsepower packaged compressors were selected for the main station. Each compressor has been engineered to handle both low and high pressure streams. Low pressure gas is boosted through three compression stages then tied into the discharge of the fourth cylinder which boosts the high pressure stream. The plant can process 20 mmcfd. at 850 to 1,000 psig. discharge with its present arrangement.

As future requirements demand, additional packaged units may be economically installed to handle the increased load. When the field is depleted the compressors may be moved to other service with little or no change in piping or manifolding.

Let us assist you in planning an economical solution to your production problem. Call or write . . .

THE J. B. BEAIRD COMPANY, INC.

Shreveport, Louisiana

A Subsidiary of American Machine & Foundry Company

BEAIRD

another AMF product

PACKAGED COMPRESSOR PLANTS

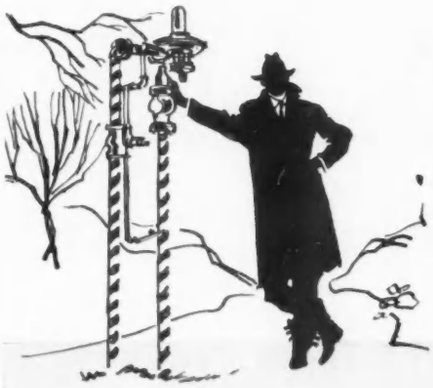
LOWEST COST PER HORSEPOWER INSTALLED

SHREVEPORT, LOUISIANA. *Sales Offices: Dallas, Houston, Corpus Christi and Midland, Texas • New Orleans, Louisiana • Tulsa, Oklahoma • Denver, Colorado • Los Angeles, California • Caracas, Venezuela • Cie. Ingersoll-Rand, Paris, France.*

MORE POWER PER POUND with Dowell equipment. When you specify Dowell for your acidizing or fracturing treatments you get more power, pound-for-pound, than you do from any other service company. Dowell designs its pumping, mixing and blending equipment to save you money. Headed by the compact, powerful Allison aircraft-engine pumper, Dowell's equipment is streamlined to keep your costs as low as possible—consistent with the power you need for your well treatment. If your job calls for small volumes, minimum power, you don't have to pay for a lease-full of equipment. And when the job calls for big power, you get it without unnecessary bulk or weight from Dowell. This variety of versatile, specialized equipment is one more reason why Dowell offers you most value per treatment dollar. Dowell, Tulsa 1, Oklahoma.

Services for the oil industry **DOWELL**

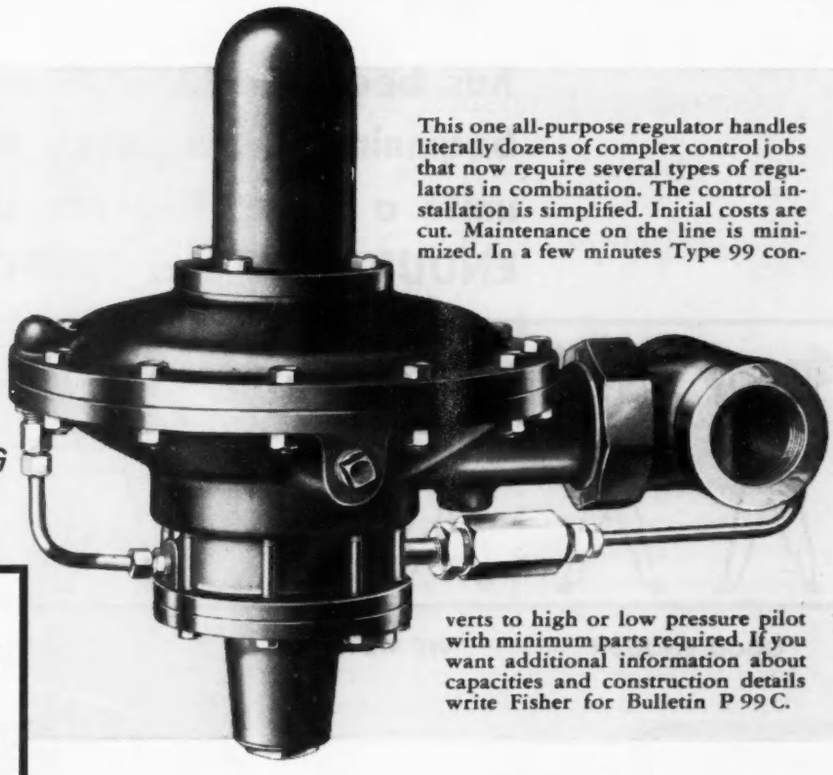
DIVISION OF THE DOW CHEMICAL COMPANY



Your *FISHER/MAN* offers you a silent sentinel with hundreds of applications

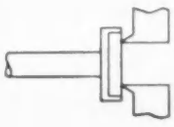
FISHER TYPE 99

MULTI-PURPOSE PRESSURE REDUCING GAS REGULATOR

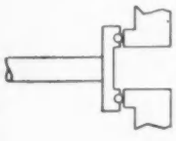


This one all-purpose regulator handles literally dozens of complex control jobs that now require several types of regulators in combination. The control installation is simplified. Initial costs are cut. Maintenance on the line is minimized. In a few minutes Type 99 converts to high or low pressure pilot with minimum parts required. If you want additional information about capacities and construction details write Fisher for Bulletin P 99C.

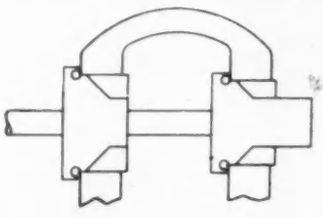
ORIFICE SIZES— INNER VALVE STYLES



⅞" Composition Disc Single Port. Max. Inlet 250 psi. 1⅛" Composition Disc Single Port. Max. Inlet 150 psi.

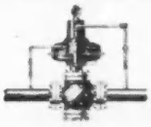


⅞" "O" Ring Single Port. Max. Differential 250 psi. 1⅛" "O" Ring Single Port. Max. Differential 250 psi. (with heavy main spring) 2" "O" Ring Single Port. Max. Differential 40 psi.



2" "O" Ring Double Port. Max. Differential 100 psi.

1. **The factory pre-set spring provides powerful lock-off action.**
2. **Large, effective area of main diaphragm in combination with relay pilot assures trouble-free accuracy.**
3. **It is only a matter of minutes and a minimum of parts to convert to high or low pressure pilot.**
4. **2" threaded or flanged inlet and outlet. Standard hi-tensile iron body for up to 150 PSI inlet, XH or bronze body for up to 250 PSI inlet.**
5. **Composition valve disc assures tight shutoff on zero flow and excellent regulation from low flow to maximum capacity.**



IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD . . . CHANCES ARE IT'S CONTROLLED BY . .

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario / London, England

CONTINENTAL EQUIPMENT CO. DIVISION, Coraopolis, Pennsylvania

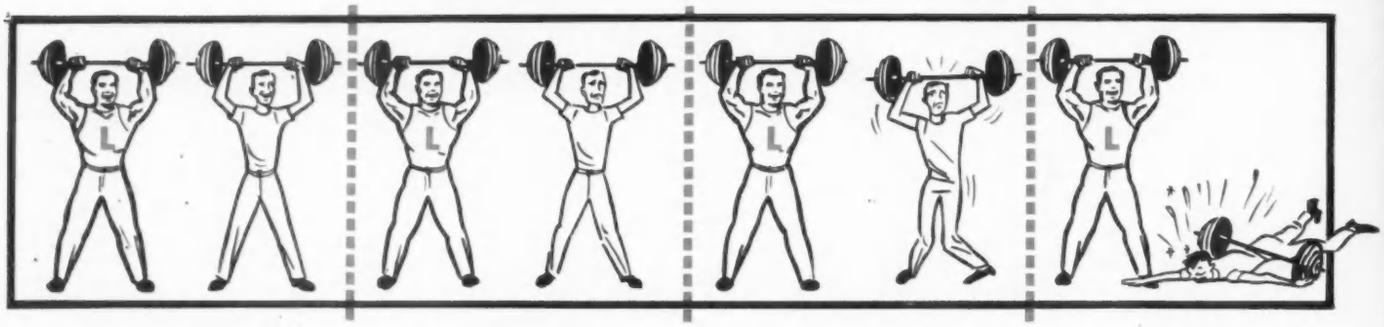
FISHER® Controls

SINCE 1880

Sure! LUFKIN UNITS ARE HEAVIER!

"H--- for STOUT"

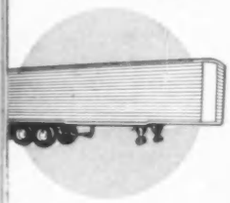
has been the LUFKIN motto from the very beginning . . . a policy that has given LUFKIN units a reputation for UNSURPASSED ENDURANCE and PERFORMANCE . . .



GOOD ENOUGH | WE WONDER . . . | . . . LATER | WUPS

PUMPING UNITS

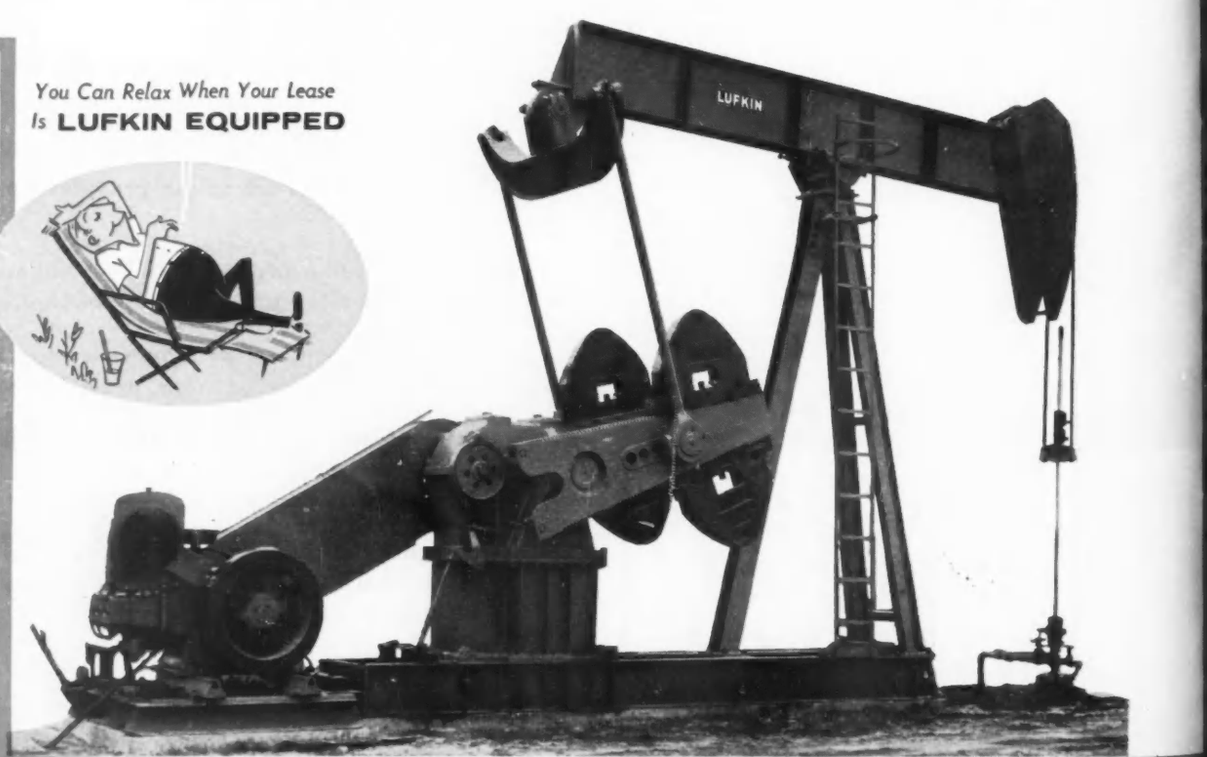
GAS ENGINES



TRAILERS

SPEED INCREASERS AND REDUCERS

You Can Relax When Your Lease Is **LUFKIN EQUIPPED**



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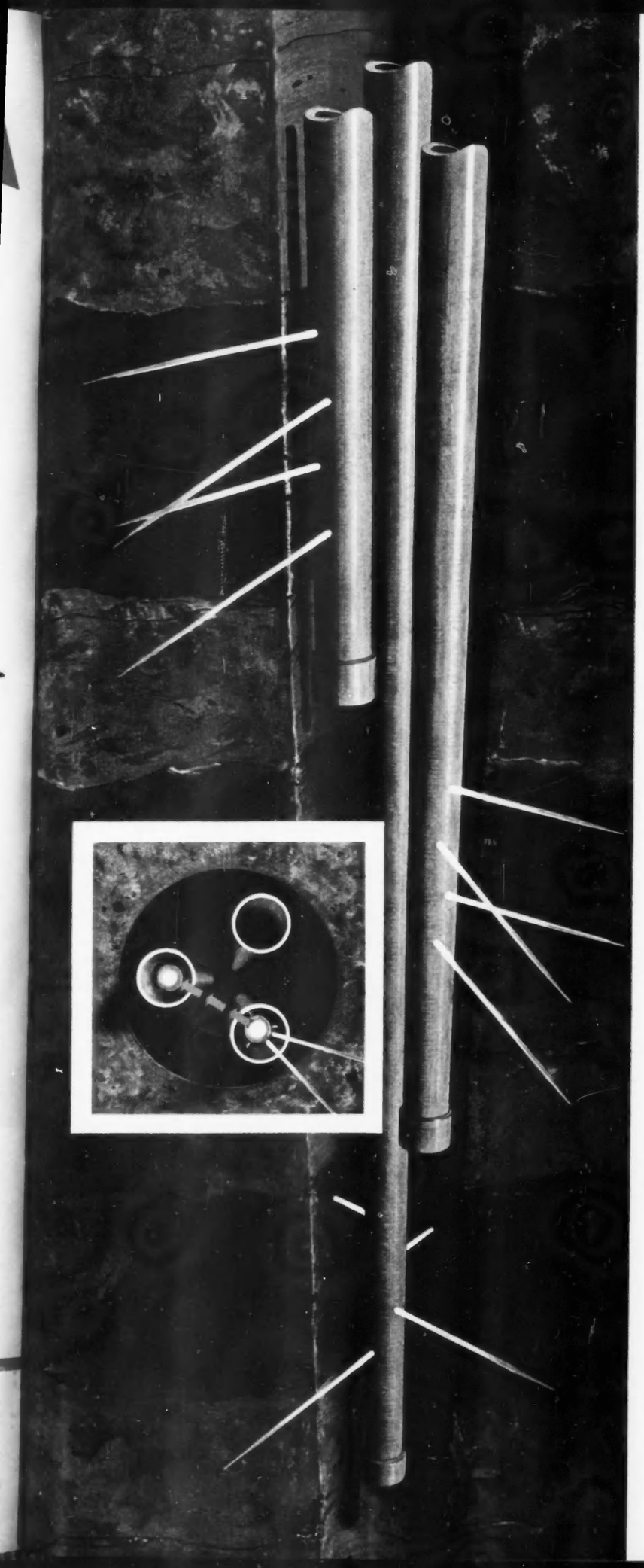
Lufkin equipment in Canada is handled by
THE LUFKIN MACHINE CO., LTD., 9950 65th Avenue, Edmonton, Alberta, Canada, Regina, Saskatchewan, Canada



Oriented Perforating by Schlumberger . . . an Exclusive Development for New Multiple Casing Completions

Three oil wells in a single borehole . . . here is a modern completion method that reduces capital investment and lowers costs of oil production. *Schlumberger Oriented Perforating* is the modern perforating method that makes this progress possible.

The use of slim 2⅞″ casings—cemented side by side in the same borehole to effect dual or triple completions—requires a perforating device that directs the shots to avoid penetration of adjacent casings. Schlumberger engineers have designed such a device that "sees" these adjacent casings and, at the same time, allows the operator to turn the aligned shaped charges into an unobstructed path. The result—each casing is efficiently perforated to form an independently producing well.

Schlumberger Oriented Perforating makes use of the Scallop Gun, another Schlumberger development for slim-casing completions. The Scallop Gun, a 2″ O.D., steel-carrier, shaped-charge perforator, is designed to leave no debris to bridge the small-diameter pipe and interfere with production.

The future of the industry depends on the introduction of techniques and equipment that reduce the cost of producing oil. You can depend on Schlumberger to keep pace with services which, like Oriented Perforating, contribute to further progress and economy.

THE EYES OF THE OIL INDUSTRY®

SCHLUMBERGER

THE LUFKIN MACHINE CO., LTD., 9950 65th Avenue, Edmonton, Alberta, Canada, Regina, Saskatchewan, Canada

CF&I Seamless Casing and Tubing Service

provides more than quick delivery

The giant steelman represents CF&I's ability to manufacture quality steel products for the petroleum industry, *and* to provide customer service backed up by intimate knowledge of oil country requirements. CF&I Seamless Casing and Tubing is an excellent example. Here's why:

CUSTOMER SERVICE: In addition to quick delivery, CF&I has qualified personnel who are ready to work with you on your Casing and Tubing problems. These men are specialists and know the problems common to the Petroleum Industry.

QUALITY CONTROLS: Mill controls are used to assure *straight* steel pipe with *precision* threading. Straight pipe is essential for smooth drilling operations. Precision threading, which minimizes galling, provides strong joints that prevent leakage and withstand high internal and external pressures.

CF&I Seamless Casing and Tubing is made to meet API STD 5A specifications, and is available in sizes 2⅜" through 9⅝" O.D. Let us serve you.

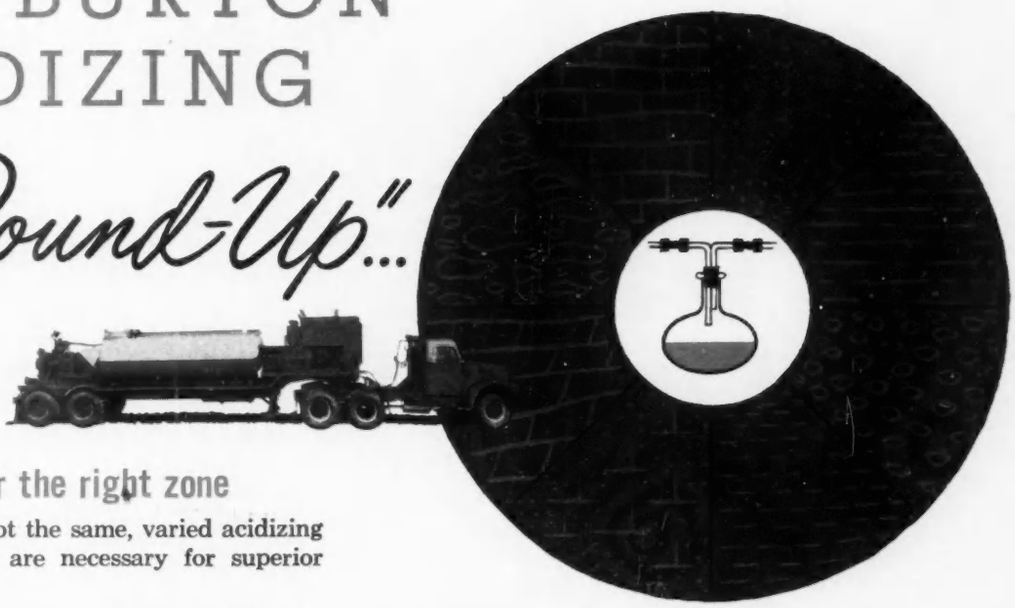
CF&I STEEL **SEAMLESS** *casing and tubing* API

7073

THE COLORADO FUEL AND IRON CORPORATION • DENVER, COLORADO

HALLIBURTON ACIDIZING

"Round-Up"...



a right type acid for the right zone

Because every well is not the same, varied acidizing materials and techniques are necessary for superior results.

Halliburton has available many basic chemicals and additives that may be combined in different ways to satisfy most special well conditions.

Halliburton Acidizing Services and Halliburton trained and experienced operating personnel can aid in helping you determine the right type acid for the right zone... helping to increase production in new wells and improve production in older wells.

After a careful and complete analysis of your formation requirements, determined by a Halliburton Chemical Laboratory examination, one or a combination of these Halliburton additives may be the "stimulation factor" for profitable production results.

HALLIBURTON REGULAR ACID...
an effective and economical stimulation aid for most limestone and dolomitic formations.

HALLIBURTON NON-EMULSIFYING ACID...
a composition of regular acid, plus an individually selected Halliburton "N" compound designed to aid in preventing emulsions during acidizing. Halliburton "N" agents may also be sediment dispersants which act by oil coating the insoluble silicates while leaving the calcareous rock water wet.

HALLIBURTON PENETRATING ACID...
composed of regular acid plus an additive for surface tension reduction. The surfactant effectively lowers the surface tension of both raw and spent regular acid and can also be used with other acid mixtures. Its greatest application is in formations normally requiring prolonged "clean-up" time after treatment which may be due to "jamin-effect".

HALLIBURTON MUD CLEANOUT AGENT (MCA)...
regular acid containing a unique synergetic blend of surfactants called Morflo II. This Morflo II-Acid combination, MCA, is specifically designed to remove flow restrictions caused by water, emulsions and/or solids.

HALLIBURTON HV ACID...
its name implies high viscosity. Retards chemical reaction of acid on limestone formations allowing penetration of unreacted acid a greater distance from bore hole. Also used as diverting agent.

HALLIBURTON Fe ACID...
a regular penetrating acid with a conditioning agent to minimize re-precipitation of dissolved iron salts and oxides during acidizing. Best suited where abnormal amounts of iron are dissolved by acid prior to its spending on formation, such as conditions associated with disposal and injection wells.

HALLIBURTON HF ACID...
a combination of hydrochloride and hydrofluoric acids specifically designed for treatment of siliceous formations.

HALLIBURTON ACID INHIBITORS...
a necessary protective additive used in all Halliburton acid solutions to reduce reaction on downhole equipment.

When you consider the stimulation benefits of Halliburton acids and inhibitors... there can be no other acidizing choice!

Help your well to get the right type acid for the right zone.

HALLIBURTON CHEMICAL SERVICES

HALLIBURTON OIL WELL CEMENTING COMPANY • DUNCAN, OKLAHOMA

Two Types of Wire Rope on Cleanout Job. Here's a recent cleanout assignment by Standard Drilling Co. in Pan American's J. M. Young No. 1, a 6350-footer near Oklahoma City. At the time of the photograph; two types of Bethlehem wire rope, ⅞-in. 6 x 17 Seale, and 9/16-in. 6 x 7 sand line, each with fiber core, were rounding out several weeks of operation. And doing a good job, too.

That's the story throughout the oil country. Wherever you look, you'll find Bethlehem wire rope hard at work. It's good sound rope, always dependable, always doing its part in paring down operating costs.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA. *Export Distributor:* Bethlehem Steel Export Corporation

Mill depots and distributors from coast to coast stock Bethlehem Wire Rope.

BETHLEHEM STEEL

Move with Magcobar to Better Drilling

Another Well Done with Magcobar Technology

FOR COST-CUTTING PRODUCTS
THE KNOW-HOW TO USE THEM

There are three sound reasons why Magcobar can cut your drilling costs. First, proved excellence of products. Second, the industry's best trained mud engineers plan the mud program for your well and keep it running smoothly. Third, extensive research facilities keep bringing you the best drilling chemicals and additives for your particular problems.

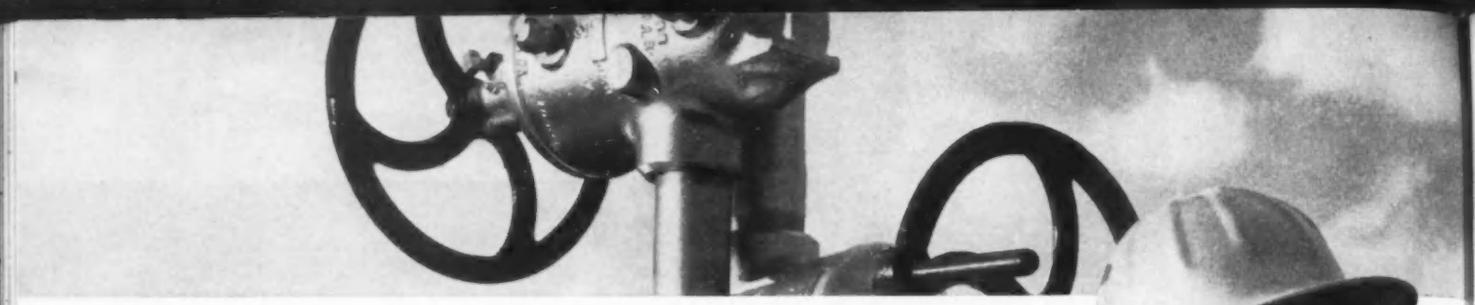
Bringing these three important reasons for Magcobar superiority to their present high level can never be the work of a day or a year by any company. Product quality is based only on careful controls and strict analyses from production to well. A mud engineer's skill is born with training in the lab—a big lab with experience—matures under a wide range of field conditions, and reaches full power in the continual mastery of new techniques, new products. And research, a word frequently sinned against, means continuing expense, continuing outlay of cash to keep on providing the drilling industry with the best products and techniques.

Save with Magcobar on your next well.

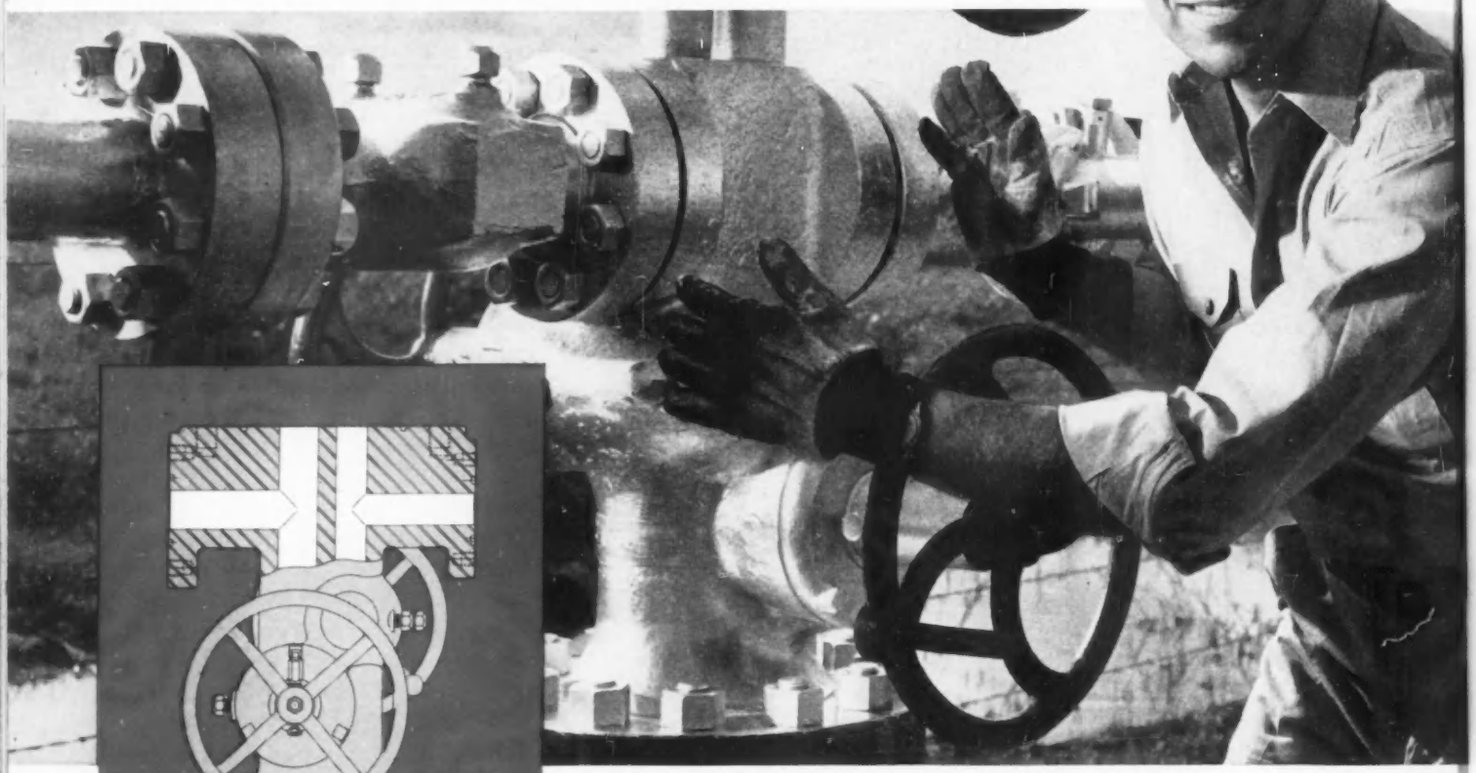
MAGNET COVE
BARIUM CORPORATION

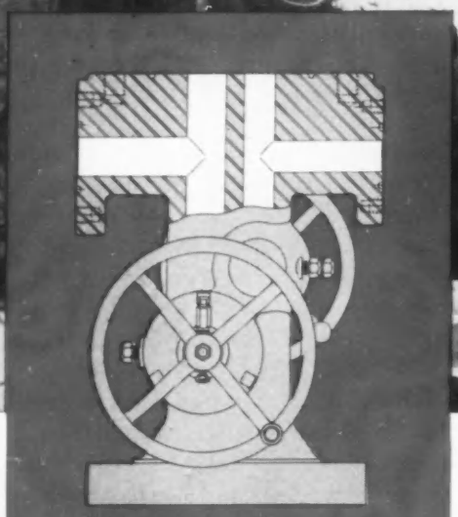
Magcobar®
Complete
DRILLING MUD SERVICE

HOUSTON



"Saves space... costs less, too"





W-K-M Cross-Type Multiple Completion Valves feature through-conduit gate construction, Teflon seat inserts for Double Tight sealing, pressure seal bonnets, superfinished stems supported on roller bearings, seating surfaces sealed from the lading flow. They can be overhauled on the line.

Sizes: 1¾" and 2"

Working Pressures: 2000, 3000 and 5000 pounds.

PRODUCT OF W-K-M's *Creative Engineering*

W-K-M® Cross-Type Multiple Completion Valves

These compact new valves simplify tree construction. They cost less than conventional tree components, yet provide all the outstanding features found in W-K-M's world-renowned oilfield gate valves.

W-K-M integral cross-type valves are available for dual and triple completions.

Next time — and every time — specify W-K-M! *At leading supply stores everywhere.*

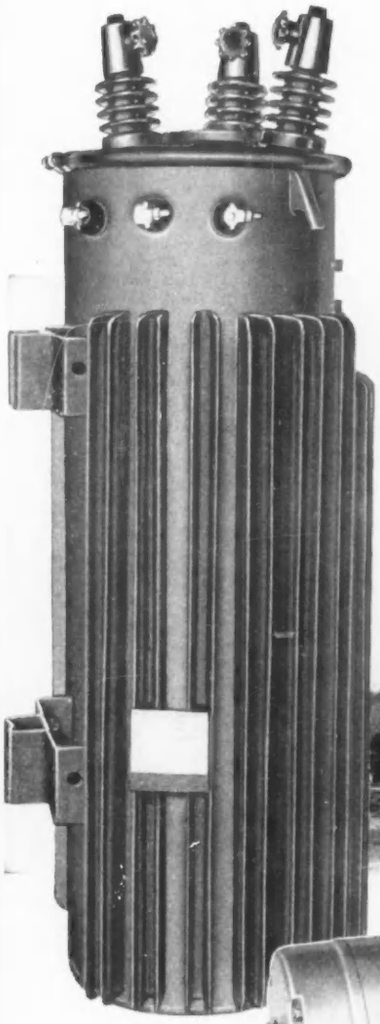
WRITE FOR CATALOG 200

W-K-M

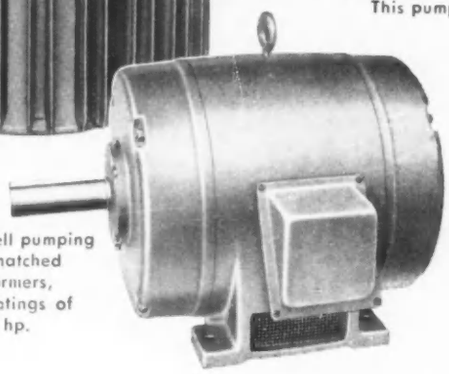
DIVISION OF acf INDUSTRIES
INCORPORATED
P. O. BOX 2117, HOUSTON, TEXAS

5920

REDUCE COSTS
of electrified
OIL WELL PUMPING



This pump, near Odessa, Texas, is driven by a 25 hp motor and transformer combination.



Wagner oil well pumping motors, with matched service transformers, are built in ratings of 5 through 40 hp.

with Wagner *MATCHED* Motors and Transformers

Here's a motor and transformer combination that's built for only one job—*dependable, efficient, cost-cutting oil well pumping.*

The motor has high torque (400 per cent) to handle initial loads without laboring or stalling. It has high slip (7 to 11 per cent) for smooth running under cyclic loads. Class B Insulation protects the motor windings, provides greater thermal capacity to safely absorb the heat from peak loads. You get more production with less energy consumption because the motor is built for the job.

The transformer is matched to the motor—puts an adequate, dependable power supply close to the load. You can electrify oil well pumping leases by bringing the high voltage line to each well installation . . . operate each well individually. You save up to 25 per cent in line materials and labor – eliminate many dead ends – reduce system losses by as much as 65 per cent.

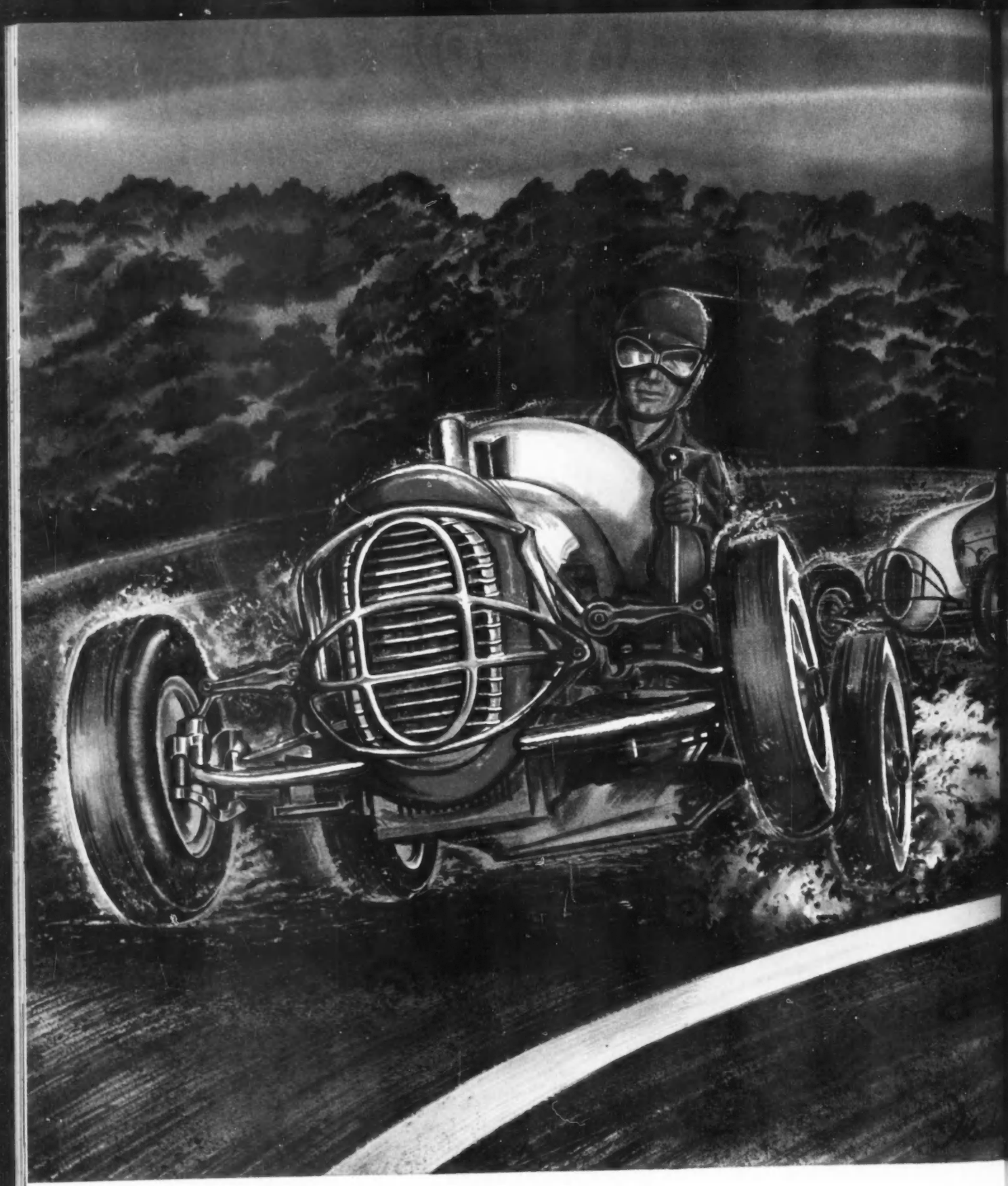
Your nearby Wagner field engineer will be glad to tell you about the Oil Well Pumping Motor and Transformer Combination, help you plan oil well pumping, gathering and water-flooding systems, assist you in solving your electrical problems. Call him today, or write for Bulletin EU-426A.

WM59-14

Wagner Electric Corporation

6457 PLYMOUTH AVENUE, ST. LOUIS 33, MISSOURI

SERVING 2 GREAT GROWTH INDUSTRIES . . . *ELECTRICAL . . . AUTOMOTIVE*



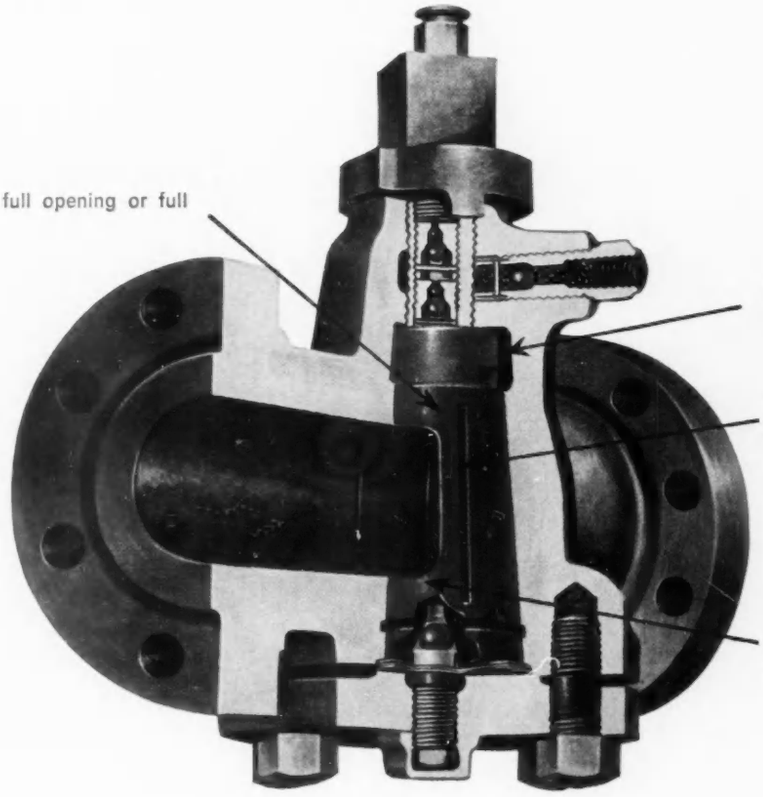
ROCKWELL-Nordstrom **VALVES**

Where control is vital

It isn't just speed and power that wins races . . . it's *control* that makes consistent winners.

It's the same with valves. Valves that are awkward or slow to operate may "lose the race" against impending disaster or costly flow control errors. That's why, wherever flow control must be instantly responsive, you'll see Rockwell-Nordstrom lubricated plug valves. Their *quarter-turn* lubricated closure means perfect control *every time.* The drawing below shows why these valves are so often demanded for the flow control jobs where errors can't be tolerated . . . and why they make flow control foolproof on every service.

PERFECT, FOOLPROOF VALVE OPERATION


¼ turn for full opening or full closure.
Lubricant "cushions" plug for instant response.
Sealdport® pressurized lubricant sealing means *positive* shut-off.
Lubricant assures smooth, easy operation.

Rockwell-Nordstrom is the original and world's most complete line of lubricated plug valves with sizes from ¾" to 36" and pressures to 15,000 lb. Available at leading oil field and industrial supply houses everywhere. For details, see your supplier or write: Rockwell Manufacturing Company, Pittsburgh 8, Pa. If you live outside the U. S. A., write: Rockwell International Division, Pittsburgh 8, Pa.

ROCKWELL-Nordstrom VALVES

another fine product by

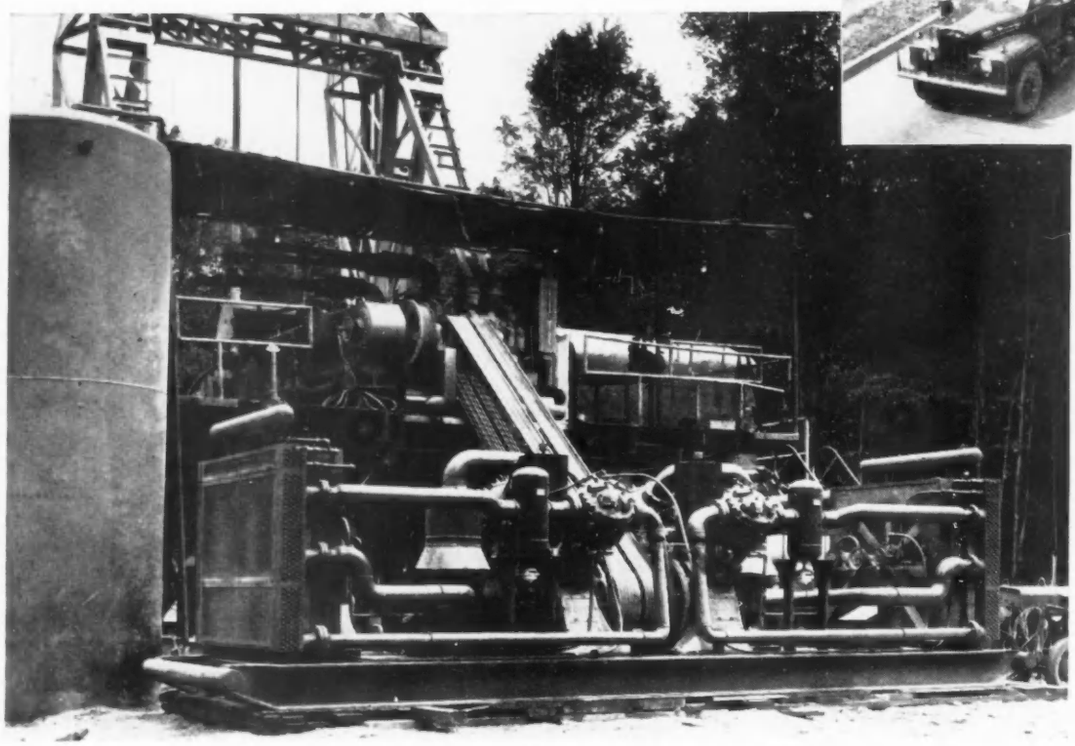
ROCKWELL

®Reg. T.M. Rockwell Manufacturing Company

For air drilling anywhere . . .

JOY COMPRESSORS

with over-the-road portability



Joy AR-1 rig driven compressor operating in West Virginia after long haul over dirt roads.

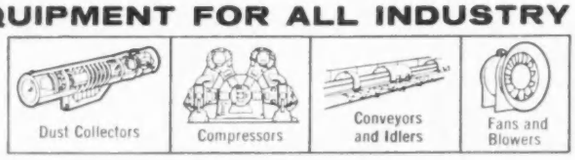
Joy "package" air drilling compressors are mounted on a single skid, completely within normal size limits for highway transportation. The bother and delay of special transport permits is eliminated.

These Joy compressors are designed specifically for air drilling service. The compressor units are built with the same durability found in rugged, heavy-duty stationary machines. All are designed for continuous operation over long periods.

One added advantage: remote controls at the driller's console permit the driller to operate the entire unit. An extra man at the compressor is unnecessary. Automatic controls regulate compressor loading and unloading at discharge pressure settings.

Air drilling operators can choose from three different self-driven or rig-driven models. Capacities from 50 to 6300 cfm; pressures from 52.5 to 500 psig. Find out more about Joy "package" compressors for fast air drilling plus fast over-the-road hauling. For additional information, write for bulletin 350-30.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY



JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

Drillers on the move..

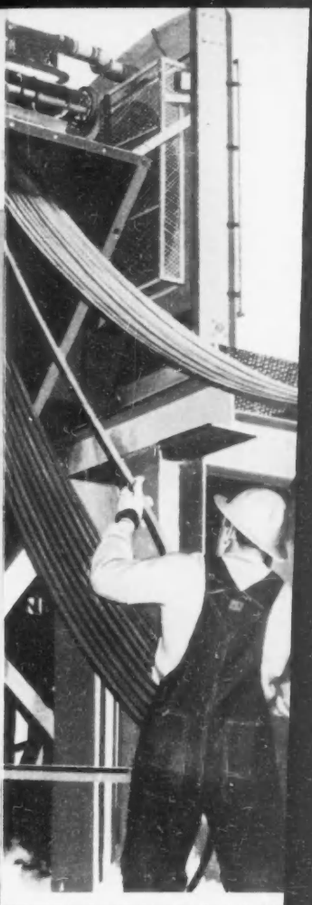
depend upon

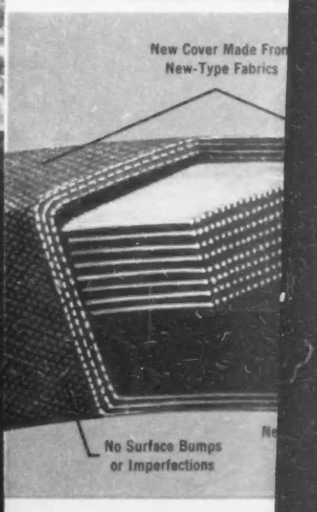
NEW BEDFORD
"NONE BETTER"
PURE MANILA

..the drilling man's rope

The proven dependability and economy of Manila rope is enhanced by New Bedford's knowledge of rope manufacture. Their special treatment reduces the damaging effect of rot and mildew for longer life even in swampy, humid areas. New Bedford rope resists water and oil absorption, making it ideal for *any* job around a drilling rig . . on land or sea. Scientific lubrication reduces internal friction for maximum rope life and maximum safety at all times.

Here's a rope that costs no more, yet means so much more in safety, ease of handling, longer life. Be a user of New Bedford Manila rope . . the finest in the oil fields . . through Continental-Emsco, worldwide.

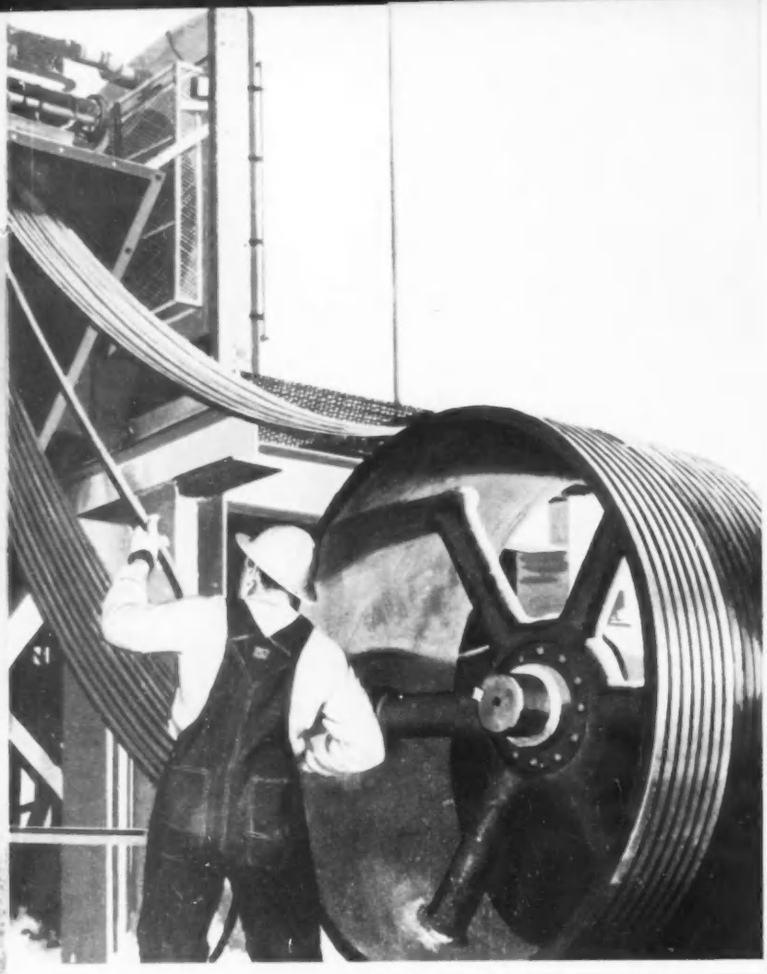


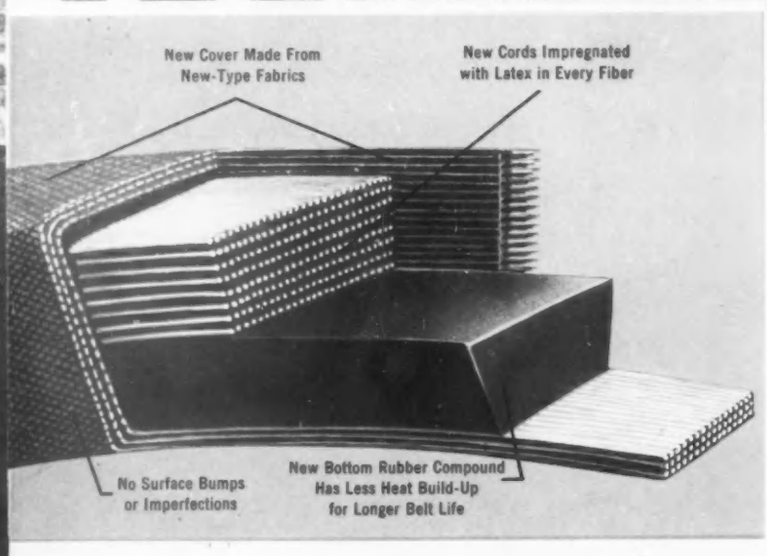


C-E Gre

match

NEW! *C-E Green Triangle Spinning Lines . . . the green strand is the exclusive mark of quality unequalled in the oil industry.*





RIG UP *with* GREEN TRIANGLE SUPER V-BELTS

40% *more capacity*

ALL NEW CONSTRUCTION provides built-in reserve strength and a vibration free balance for handling 40% more horsepower . . with *no* increase in price.

ALL NEW CORDS, impregnated with latex in *every* fiber to assure maximum shock resistance and to guarantee that each cord pulls its share of the load.

ALL NEW MOLDING METHOD eliminates all inner and outer imperfections and harsh surface bumps for *even* longer belt life. Stretch has been reduced for less field adjustments.

ALL NEW COVERS, made by a new molding technique which blends new-type fabrics into a homogeneous unit, greatly extend running life of belts . . provide better flexibility over small sheaves.

C-E Green Triangle Super V-Belts are available exclusively from Continental-Emsco in matched sets to assure uniform high quality, grade, size, diameter and freshness.

throughout the World

DRILLERS ON THE MOVE

SPECIFY CONTINENTAL-EMSCO

open here for drilling equipment

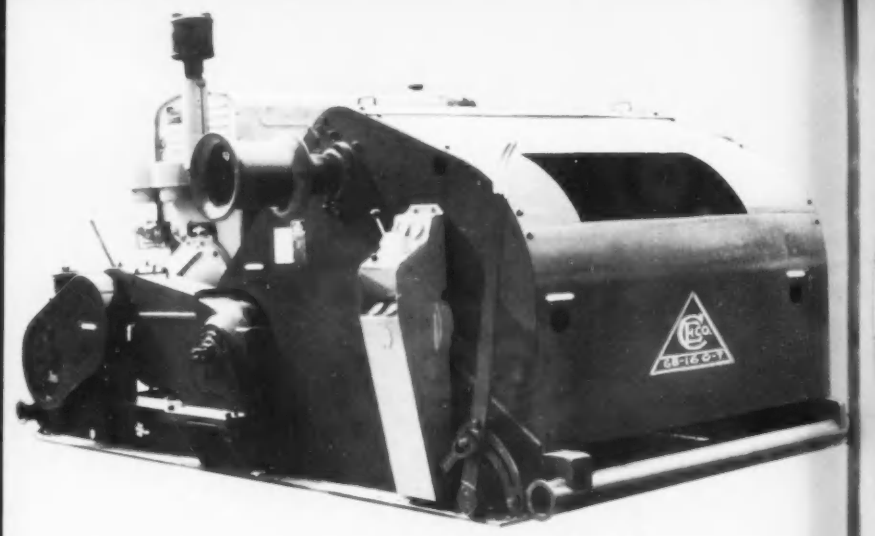
COMPLETE

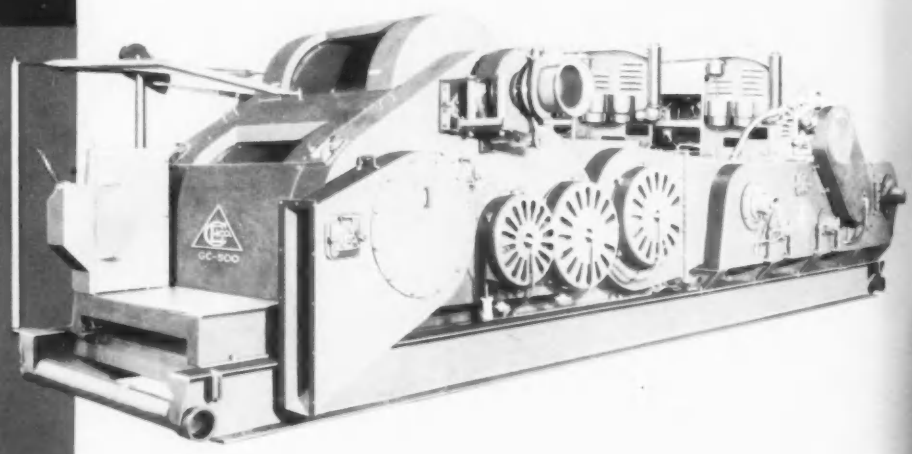
Engine-Drawworks

PACKAGED UNITS

Continental-Emsco

G Series Drilling Rigs

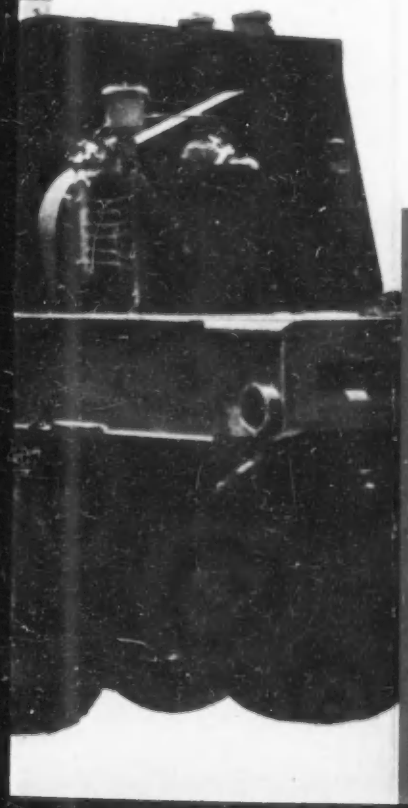




GB-160 and GB-250—one or two-engine, torque-converter units for split-rig arrangement. 200 and 300 hp.

GC-350 — one, two or three-engine, torque-converter unit, may be used as a split-rig arrangement or as a combined unit with mud pump drive from the compound. 450 hp.

GC-500—two or three-engine unit with optional engine drives of Airflex clutches, torque converters or fluid couplings. 600 hp.



Profitable drilling in the shallow to medium depth range is assured with C-E's compact, tough G Series, single-package drilling rigs. These rigs are made in the world's most complete oil field equipment plant. This *extra high quality* gives you the added performance needed for getting and completing jobs . . with more profits. Portability, performance and flexibility are designed into all of these units. Big rig features include air-operated selective transmissions, driller's control console, enclosed water cooled brake rims (water spray on the GB-160) and oil pressure lubrication. Check the complete G Series line for the rig that meets your requirements best . . used around the world by *drillers on the move.*

C-E TRAVELING BLOCKS

Low center of gravity eliminates canting, assures a straight travel, fast falling block . . forged steel rims are flame hardened to increase wire line life . . reversible lubrication cartridge makes it possible to lubricate from either side as desired.

CONTINENTAL-EMSCO

TRAVELING BLOCKS

HOOK BLOCKS

SWIVELS

. . each designed to do tough drilling jobs better. . longer

C-E HOOK BLOCKS

Combines the advantage of C-E RA series traveling blocks with Web Wilson Hydra Hooks. Small in size . . ample weight . . slim-line design.

C-E SWIVELS

One-piece cartridge-type washpipe packing withstands highest mud pressures and is easily replaced . . platform mounted gooseneck can be removed for washpipe and packing replacement without disturbing rotary hose.

UNEXCELLED PORTABILIT

. . makes the largest C-E A Series Rig easy

Drillers on the move the world over have found that Continental-Emsco's A Series rigs are designed for fast, low cost moves . . an important point in today's highly competitive market. Each rig in the A Series is designed to break down into easily transportable packages of ideal weight and dimensions. Assembly and disassembly is fast and sure.

Versatility is designed into these rigs. Separate drawworks and sectional power ends offer maximum flexibility in meeting various horsepower requirements, types of substructure and the number and location of mud pump drives.

A-5

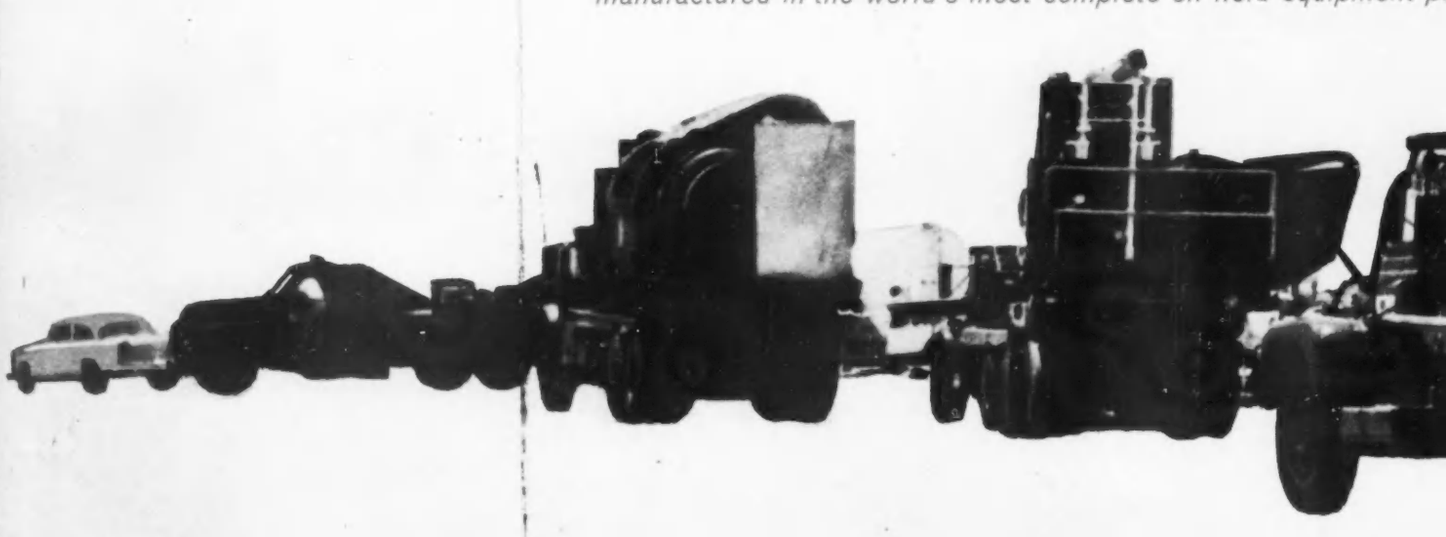
A-8

A-1

A-1

* Ba

When you want power, yet compactness . . portability, yet ruggedness . . economy, yet versatility . . investigate competitive advantages of the high quality Series A rigs . . manufactured in the world's most complete oil field equipment p



LITY

easy to move

P/

A-550 ..... 700 hp*

A-800 ..... 1000 hp*

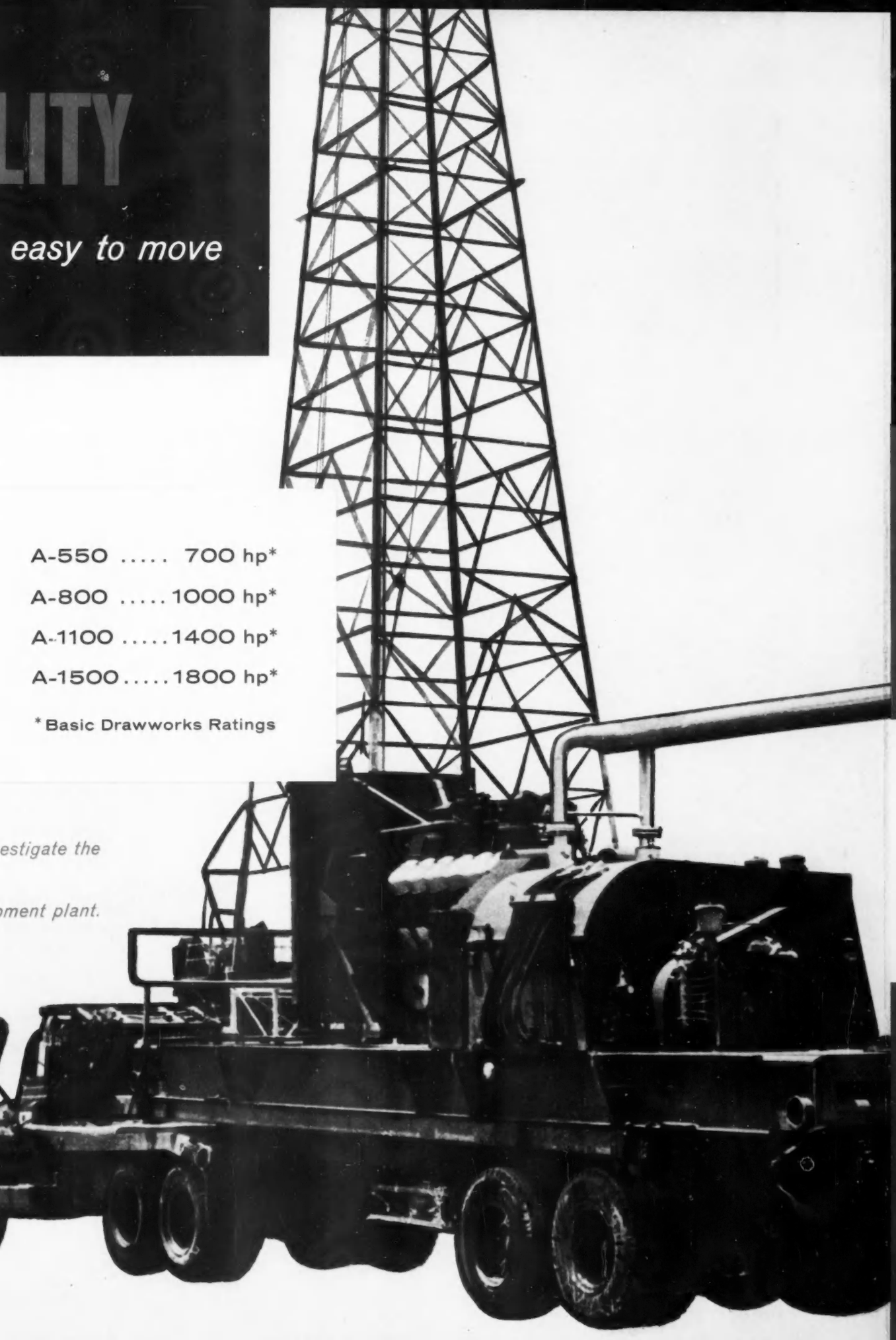
A-1100 ..... 1400 hp*

A-1500 ..... 1800 hp*

*Basic Drawworks Ratings

estigate the

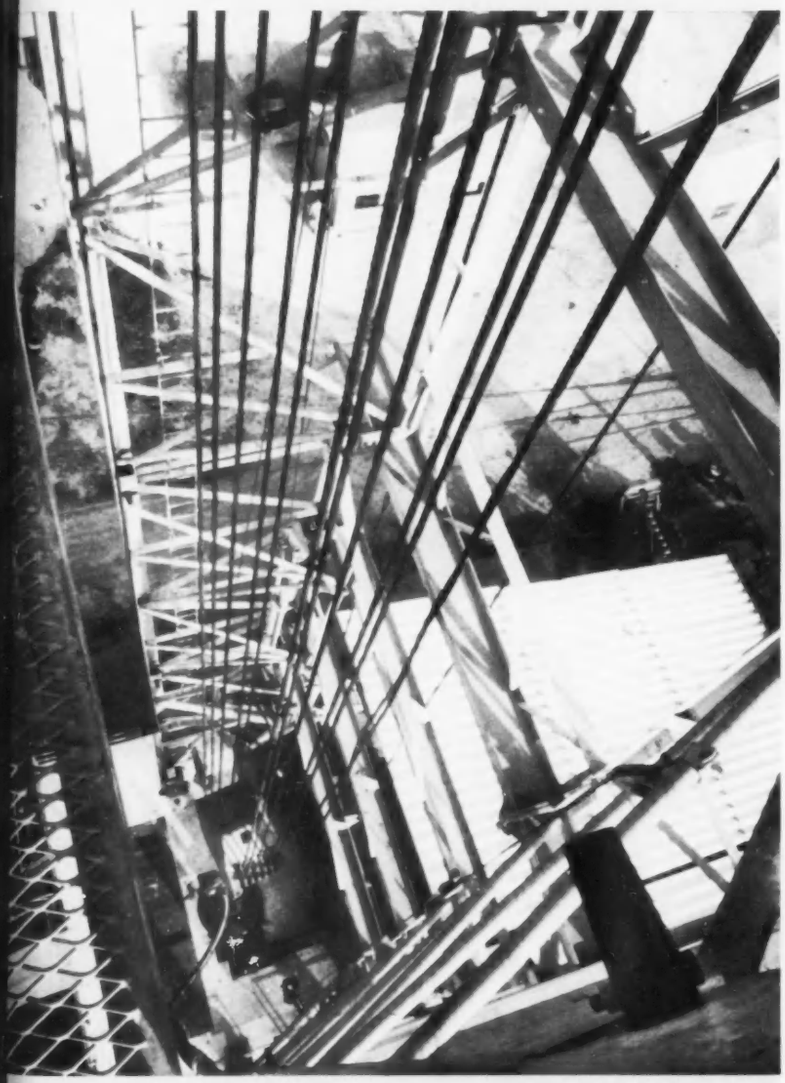
oment plant.



C-E TI

"POWERSTEEL"®

. . always available from
STOCK *throughout the world*
. . exclusively at C-E stores or
through C-E representatives



You get a keen sense of satisfaction rigging-up with POWERSTEEL. A satisfaction that you are using the best . . an extra high strength wire rope more than equal to the greater horsepower of modern rigs. A satisfaction of using a line designed . . *through metallurgical research* . . to provide fatigue-resisting qualities to withstand the continual shock and wear of faster drum speeds. There's a satisfaction, too, of knowing that your drilling contracts will be completed quicker with less chance of *wire line failure downtime* and that this stronger wire line results in more ton miles per dollar. Let us explain Broderick and Bascom's *tailored cutoff plan*. It's the *modern* way to bring wire line costs down to the bare minimum.

In Both Hemispheres,

CONTINENTAL-EMSCO *supplies*

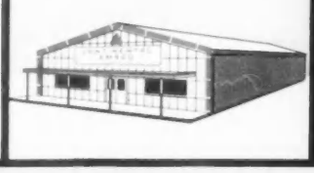
DRILLERS ON THE MOVE!

Matching C-E's high quality drilling equipment is a worldwide, highly efficient service network of over 100 stores, offices and factories. In overseas drilling areas, an additional number of C-E representatives are *on the move* providing routine supplies, as well as those critical parts that make it possible to bid, get and *profitably complete* highly competitive jobs with C-E equipment.

For Service that Sings.. Equipment that Hums..Go..

CONTINENTAL-EMSCO

Serving the Oil and Gas Industries ... Worldwide



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Export Division: 30 Rockefeller Plaza, New York, N. Y. • Continental-Emsco Company Limited • General Offices: Calgary, Alberta, Canada
Continental-Emsco Company C. A., Caracas, Venezuela • Plants: Houston and Garland, Texas; St. Albans, Herts., England • *Representatives in All Principal Oil Fields of the World*

Another FIRST by LANE-WELLS

Single Line Directional Perforating for Multiple String Completions

FASTER

MORE ECONOMICAL

POSITIVE POSITIONING

SURFACE RECORDING

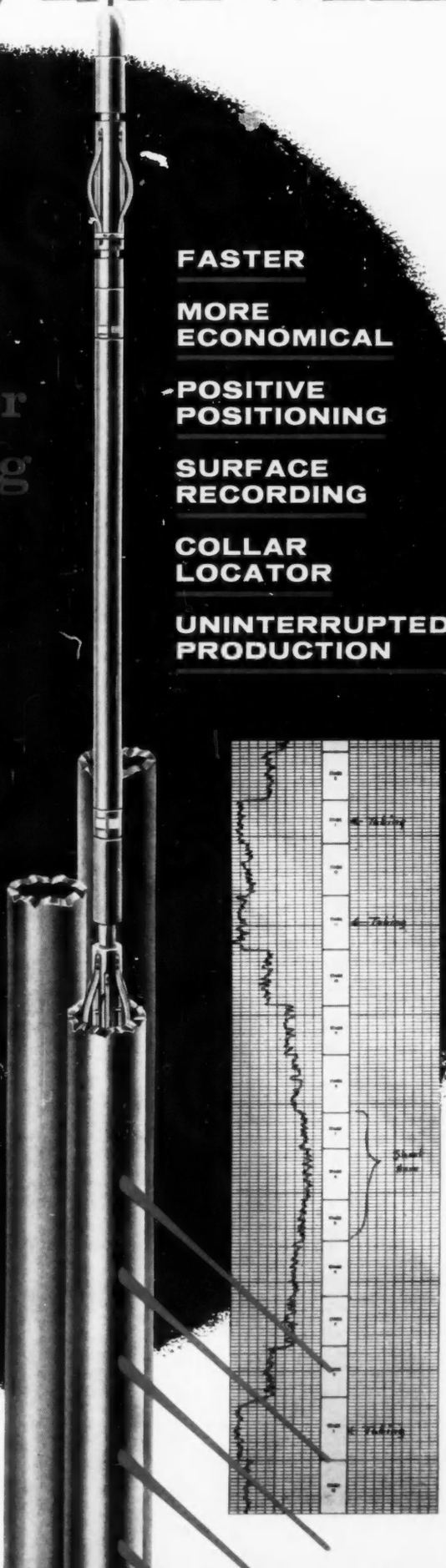
COLLAR LOCATOR

UNINTERRUPTED PRODUCTION

Lane-Wells new Directional Perforating Service safely and positively perforates a single string in a multiple string, tubingless completion on a single run in the well. The other casing strings in the well are not used in any way—they may be kept on production during the entire operation.

A Collar Log and a complete record of pipe and perforation orientation are made at the surface for positive checking at each stage of the operation.

For additional information about this new service ask your Lane-Wells representative or write:



LANE-WELLS COMPANY

A DIVISION OF DRESSER INDUSTRIES, INC.

P. O. BOX 1407 • HOUSTON 1, TEXAS

No joint leakage...no creep with AMERICAN IRON Straight Grip Tool Joints!

No worry about joint leakage or creep with our 4 POINT SEAL PROTECTION . . . in fact, the seal actually becomes TIGHTER as the tension load and pump pressure are increased.

AMERICAN IRON Straight Grip tool joints are *three times* as strong as the pipe they connect! You'll like the quick, easy way this hand applied Straight Grip can be removed and installed right at the rig. STRAIGHT GRIP tool joints are ideal for handling high tensile drill pipe.

These are just a few of the reasons why you buy quality when you specify AMERICAN IRON.

AVAILABLE THROUGH YOUR SUPPLY STORE

AMERICAN IRON
Straight Grip
TOOL JOINT

AMERICAN IRON

Another AMF Product
PETROLEUM EQUIPMENT

AMERICAN IRON & MACHINE WORKS COMPANY, INC
518 North Indiana Avenue Oklahoma City Oklahoma
Subsidiary of AMERICAN MACHINE & FOUNDRY COMPANY

AMERICAN IRON & MACHINE WORKS CO. INC. A OKLAHOMA CITY